United States Patent [19]

Dotto

[11] **3,785,383**

[45] **Jan. 15, 1974**

[54] **ELECTROSTATIC WAND**

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[52] **U.S. Cl.** **128/414**
[51] **Int. Cl.** **A61n 1/06**
[58] **Field of Search** 128/404, 413, 414, 128/415, 303.13; 313/152

[56] **References Cited**

UNITED STATES PATENTS

1,570,041	1/1926	Clark	128/414
1,655,783	1/1928	Gallois	128/414
2,286,110	6/1942	Running	128/404

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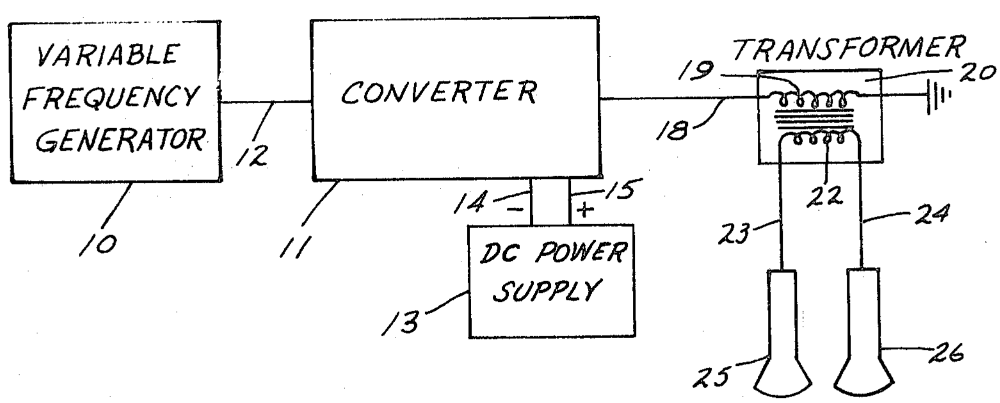
[57] **ABSTRACT**

Electrostatic means radiating electrical energy at selected frequencies of the order of megacycles per second is safely and harmlessly coupled capacitively to tissue structure of a human being or of an animal with no significant flow of electrons for reducing sensitivity to pain, at least temporarily. The radiating means may comprise an evacuated glass envelope containing a selected atmosphere of inert gas and also containing an electrode that is intermittently subjected to an electropositive voltage during certain portions of the cycle to promote positive space charges within the envelope together with a controlled amount of ionization of said atmosphere and the production of selected forms of electromagnetic radiation such as infra red light, ultra violet light, visible light, and mixtures thereof.

4 Claims, 6 Drawing Figures



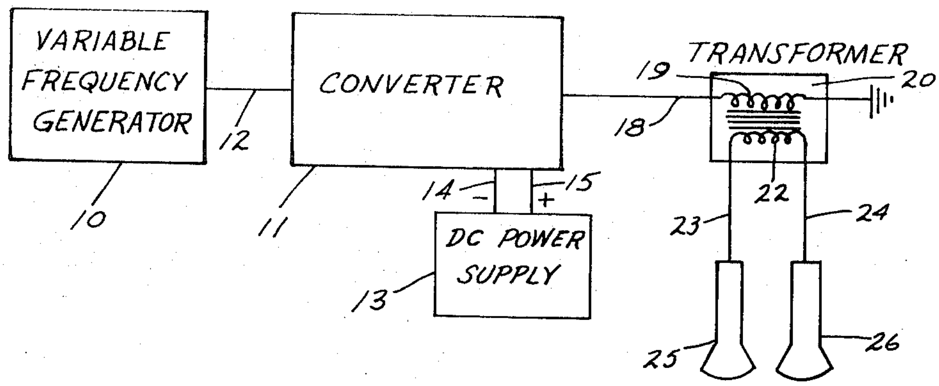


Fig. 1

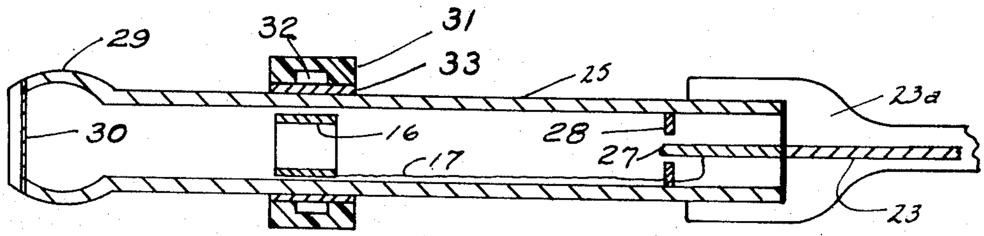


Fig. 2

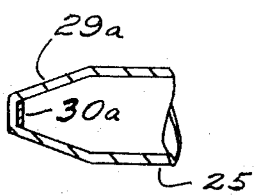


Fig. 3

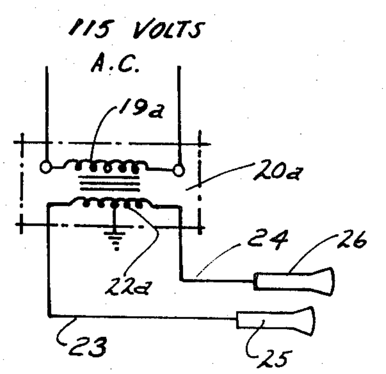


Fig. 4

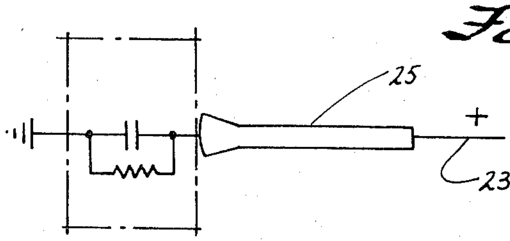


Fig. 6

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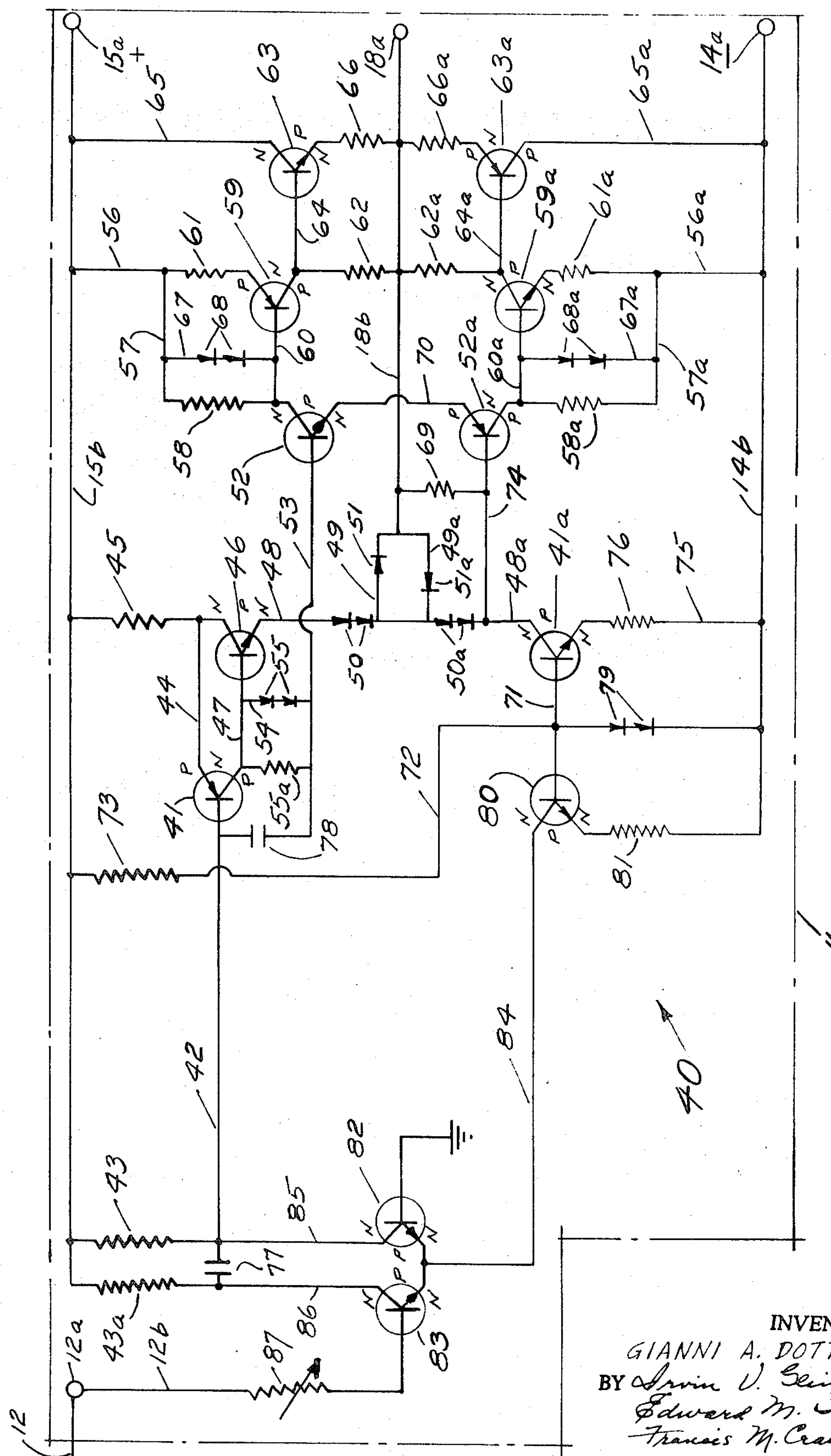

Fig. 5

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ELECTROSTATIC WAND

BACKGROUND

There are many known influences that can reduce or augment the threshold of pain reaction as opposed to pain reception. For example, devices employed heretofore for the relief of pain include heating devices such as hot water bottles, hot packs, electrically heated pads and blankets, radiant heating devices, diathermic devices, whirlpool baths and the like. While such devices are generally effective they are subject to certain disadvantages and/or limitations. Conductive heating devices heat only the areas with which they are in contact and are not particularly suited for irregular bodily surfaces. Conductive heating devices, such as the whirlpool bath, heat all immersed areas generally rather then locally.

Additionally, it has long been known that skin or cutaneous tissues are quite sensitive to pain whereas certain organs that are more deeply disposed within the body, such as the viscera, are quite insensitive to pain when judged by criteria applicable to the skin but are sensitive to tissue distension or muscular contraction. For example, a limb muscle can be quite painful if exercised while its blood supply is cut off, and other relatively deep tissues to pain include the periosteum (bone covering). Thus, depending upon the nature and location of the factors causing the pain sensation, analgesic methods and/or devices in many instances need to be applied in particular locations for effective relief from pain.

SUMMARY

Accordingly, the principal objective of the present invention is to obviate the above-noted difficulties and efficiencies. This is accomplished, in accordance with the present invention, by the provision of means establishing electropositive space charges at high frequencies within an evacuated glass envelope with or without accompanying electromagnetic radiation. It can be applied to tissue structure safely and at a desired location for reducing, at least temporarily, sensitivity to pain.

DESCRIPTION

These and other objectives of the invention will become apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a simplified circuit diagram illustrating one embodiment of the invention including means for producing intermittent electropositive space charges within an envelope or envelopes;

FIG. 2 is a cross sectional view of one of the envelopes of FIG. 1;

FIG. 3 is a cross-sectional view of a modification of the envelope of FIG. 2;

FIG. 4 is a view illustrating a modified embodiment of the invention;

FIG. 5 is a wiring diagram of the converter portion of the embodiment of FIG. 1; and

FIG. 6 illustrates an electrical circuit equivalent to the electrical circuit of human or animal tissue structure.

The human body is known to consist of a composite mass of tissues which have electrical constants like any other substance or matter. In other words, all of the tissues act as conductors of electrical energy to a varying extent. In human tissues, all cells are bathed in lymph

or other intercellular fluid and an electrical current, in order to reach the cells, has to pass through this fluid. The tissue fluids consist of a solution of water, albumin, fibrin, and salts.

An equivalent electrical curcuit of human tissue structure is shown in FIG. 6. The electrolyte surrounding the cells is resistive. The cell electrical characteristics are illustrated as being in parallel with the characteristics of the electrolyte. The cell wall or membrane and the cell interior are each equivalent to resistance and capacitance connected in parallel. The values of capacitance and resistance are a function of cell shape radius and volume concentration. At low frequencies (below 300 megacycles) current tends to bypass the relatively high capacitance of the cells through the conductants of the electrolyte which surrounds it. As the capacitive reactance drops at higher frequencies, the current passes into the cell. At higher frequencies of the order of 1,000 megacycles current conducts primarily at the skin surface.

Experimental and clinical work with electrical energy of high frequency has shown that this form of energy can pass through electrically non-conductive surfaces because dielectric permeability or conductivity increases with the increase of the frequency of currents. The flow of an electrical force through the insulating or dielectric medium is known as a current "capacitive" current in contrast to the "conduction" current through an ordinary electrical circuit at 60 cycles per second or with direct current. The unit of dielectric permeability is that of air under normal pressure. Body tissues and fluids transmit electrical field force from 80 to 90 times better than air space.

Such prior experimental and clinical work has also revealed that structures such as fat, bones, and so forth are relatively poor conductors and may have currents conducted through them only if sufficiently high frequency currents are applied to them.

Prior clinical and experimental work has also shown that the various diseases and/or ailments to which tissue may be subjected are sensitive or are resonant at differing frequencies. Accordingly, it is desired both to provide a method and means to supply sufficient numbers of frequencies to meet all of the combinations of reactance and resistance that may be presented by living tissue structure. There are literally an infinite number of electrical circuits within human tissue and they require a range of frequencies to meet the various combinations of reactance and resistance to permit penetration of the electrical energy into the tissue structure. These equivalent electrical circuits of the tissue structure all have a different electrical impedance and they will conduct radio frequency current at a maximum peaking level when the impedences of these many circuits are at resonance with the frequency.

Apparatus embodying the present invention is indicated generally in FIG. 1 and comprises a variable frequency generator **10**. Variable frequency generators are previously known and will not be described in detail except to state that they comprise a tunable electrical circuit and suitable means selectively controlling the variable frequency output at a desired frequency.

The variable frequency output from generator **10** is fed through line **12** into a converter **11** which also received the output from a direct current power supply via connecting lines **14, 15.** The converter includes a tunable circuit which functions to deliver a converter output signal with full-wave voltage amplification of the signal received from generator **10** at a desired value of output current, and at a frequency corresponding to that provided by the generator.

The output from the converter is fed through a line **18** to the primary winding **19** of transformer **20.** The primary winding **19** is connected to ground through a line **21.** The secondary winding **22** of the transformer is connected by lines **23, 24** to a pair of glass envelopes **25, 26.** Envelopes **25** and **26** are identical in construction so that the following description concerning one of these envelopes will apply equally to the other.

Line or conductor **23** is connected at one end to the secondary winding **22** of transformer **20** and its opposite end is connected to an electrode **27** which is housed within evacuated glass envelope **25.** As shown in FIG. **2,** the inner end of glass envelope **25** is silver plated to provide a full mirror surface **28** surrounding the distal end of the electrode. The opposite end of envelope **25** is formed to a ball-shaped enlargement **29** the inner surface of which is provided with about 5 percent silver plating **30.**

Envelope **25** also houses therein an annular ring **16** of conductive material that is connected to anode **27** by a flexible connector **17.** Ring **16** is smaller in size than the internal diameter of the envelope **25** so as to be freely slidable along the extent of the envelope.

For reasons which will appear as the description proceeds, it is desirable to provide means for adjustably positioning ring **16** at selectable positions along the extent of envelope **25.** This is accomplished in accordance with the invention by the provision of a permanent magnet **32** housed within an annular housing **31** of a suitable material such as plastic that will not interfere with the magnetic attraction exerted by magnet **32** on ring **30.** Housing **31** is fitted to a sleeve **33** having an internal dimension slightly greater than the external dimension of envelope **25** so that the housing and sleeve are also slidable along the extent of the envelope. As the housing is selectively positioned at various selected locations along the extent of envelope **25,** the magnetic attraction exerted by magnet **32** on ring **16** causes the ring to follow such movement of the housing to a selected position of the ring.

In accordance with the invention, the glass envelope may contain an atmosphere which has been evacuated to a pressure of about 28 mm. of mercury prior to adding 1 mm. of mercury of a gas such as helium and also about 1/10 mm. of mercury of another gas such as neon.

During operation of the device, at proper portions of the operating cycle the transformer **20** will drive conductor **23** and the anode **27** to a potential which is electrostatically positive relative to ground. However, since the anode **26** is isolated in an essentially nonconductive atmosphere, no significant electron flow will occur because there is no significant source of electrons which can be moved by the positive voltage, and the electrode **27** merely becomes electrostatically positive. The same is true with respect to the anode contained within envelope **26** when the conductor **24** receives a positive voltage. Accordingly, the respective electrodes contained within envelopes **25, 26** function as intermittent positive electrostatic poles. When the electrode in envelope **25** is electrostatically positive, the electrode housed within envelope **26** is at a negative or ground potential, and vice versa.

The previously described quantities of helium and neon which were introduced into the atmosphere contained within envelopes **25, 26** permit a controlled amount of ionization to occur within said atmospheres. Such ionization assists in distributing intermittently positive voltage to the ball-shaped enlargements **29** and, as ionization occurs within the envelopes, electrons are drawn toward the electrodes **27,** thus promoting positive space charges within each of the ball-shaped enlargements of the respective envelopes.

Such ionization also produces a certain amount of radiant energy in the form of illumination which may pass through the glass envelopes to ground.

Preferably, envelopes **25, 26** are each provided with a shield (not shown) of high capacity with respect to the electrode that it surrounds thus diminishing the electrostatic field strength at the glass which immediately surrounds each of the electrodes. This prevents an undesired arcing which would otherwise result should a grounded conductor be placed in proximity to the exterior of the glass wall surrounding either of the electrodes.

With the device in operation, the electrodes within envelopes **25, 26** function as isolated electrostatic poles that are intermittently driven positive and negative. When one of the electrodes is placed in contact with tissue structure, as indicated in FIG. **6,** the electrostatic field which is changing rapidly in the megacycle frequency range becomes capacitively coupled to ground by the equivalent electrical circuit of the tissue structure. The skin tissue will then experience intermittent positive voltages so that electrons in the skin tissue are exposed to active agitation but essentially no current flows between the skin tissue and the glass envelope. The degree of such agitation will be greatly increased when both envelopes **25, 26** are applied to the tissue structure.

By careful pre-selection of the nature of the gases introduced into the glass envelopes and also by careful selection of the optical transmittency of the envelopes, various forms of electro-magnetic radiation can be permitted to accompany such electron agitation. Thus, at the same time the electron agitation is taking place, the tissue structure may also be irradiated with infra red light, or with ultra violet light, or with visible light, or with mixtures of the three.

Regarding such electro-magnetic radiation, it is to be recognized that skin tissue structure will have varying capacities to absorb such radiation and as absorption occurs electrons are freed within the skin tissues. More specifically, for a given frequency and exciting voltage, a certain amount of electron agitation will occur in the skin tissue structure being touched by the glass envelopes. If the skin tissue is simultaneously irradiated with light of a proper frequency, the degree of electron agitation within the skin tissue can be increased, and by controlling the light color, the depth of light penetration can also be controlled.

Obviously, there is a vast range of optical excitations that can be caused to accompany the electrostatic agitation of electrons in the tissue structure. Experiments have shown that beneficial effects from the particular combination of helium and neon, noted heretofore, are obtained. Beneficial results are also observed if the helium and neon are replaced by about 1 mm. of mercury of argon. Beneficial results have also been observed when the glass envelope is so-called "black glass" having a high ultra violet transmission and the gas atmosphere within the envelope comprises air evacuated to a pressure of about 28 mm. of mercury to which 1 mm. of xenon has been added. The beneficial results noted include relief from pain from localized cuts and bruises, relief of arthritic pain, toothaches, and the like, sometimes for prolonged periods of time.

Without intending to limit the present invention, it is my present preference to employ a transformer 20 having a secondary designed to provide voltages of the order of 12,000–15,000 volts across their secondaries.

In FIG. 3, there is shown a glass envelope of the same basic construction as that described above in connection with FIG. 2, the principal difference being that in FIG. 3 the glass envelope terminates with a pointed projection having a small end portion 29*a*. As noted heretofore, the controlled atmosphere within the glass envelope and the presence of certain selected gases therein promotes a positive space charge at the end of the envelope which is opposite the electrode. The relatively pointed shape of the electrode in FIG. 3 functions to concentrate such positive space charge and is sufficiently small in physical dimensions that treatment can be applied to a relatively small and carefully selected portion of skin tissue structure.

Those skilled in the art are aware of the fact that there is a known relationship between frequency and wave length. And it can be shown that the wave length of electro-magnetic energy corresponding to a frequency of 1,000 megacycles per second is about 30 centimeters in length, and that for a frequency of 300 megacycles the corresponding wave length is about 100 centimeters.

In accordance with the present invention the distance between the mirrored surfaces 28 and 30 is chosen to correspond with one quarter wave length of the desired frequency. Thus, by utilizing a distance between mirrored surfaces 28 and 30 of about 25 centimeters, the wave harmonics and the adjustability provided by the selectively positionable ring 16 provides effective utility over a frequency range of from about 300 to about 1,000 megacycles.

A modification of the device is illustrated in FIG. 4. The device shown in FIG. 4 differs from that of FIG. 1 in that a single transformer 20*a* having a secondary winding 22*a* provided with a center tap to ground is connected to the glass envelopes 25, 26. Transformer 20*a* has its primary winding 19*a* connected to a suitable source of alternating current such as a conventional 115 volt, 60 cycle, source. In this embodiment, the variable frequency generator, the converter and the direct current power supply elements are not employed.

The embodiment of FIG. 4 functions essentially like that of FIG. 1 in that, although the device is supplied with a 60 cycle alternating current, the glass envelopes 25, 26 function essentially as indicated above since the selective positionability of ring 16 between the reflective surfaces of mirrors 28 and 30 enables the device to function at selected frequencies within the above noted frequency range. Thus, the embodiment shown in FIG. 4 is suitable for use by physicians in their offices where the expense and complication of the additional equipment shown in FIG. 1 may not be economically feasible.

Converter 11 comprises terminals 12*a*, 14*a*, 15*a* and an output terminal 18*a* interconnected by an electrical circuit 40, as shown in FIG. 5. Terminal 12*a* is adapted to be connected to line 12 to receive a signal from variable frequency generator 10. Terminals 14*a*, 15*a* are adapted to be connected to lines 14, 15, respectively, to receive negative and positive voltages from direct current power supply means 13.

The electrical circuit superimposes the variable frequency signal upon the direct current voltage at differing levels thereof and thereby provides at output terminal 18*a* a full-wave output signal of desired wave form, such as a square wave, and corresponding to the frequency of the selectable variable frequency input signal. In accordance with the invention, said electrical circuit comprises semiconductor materials such as diodes and transistors of both the p-n-p and the n-p-n type and employs, in a follower type circuit, complementary symmetry to take advantage of the opposite bias and signal polarities of the transistors.

The electrical circuit includes negative line 14*b* and positive line 15*b* with output signal line 18*b* interposed therebetween. Lines 14*b*, 15*b*, respectively, are connected to terminals 14*a*, 15*a* and each is interconnected with output signal line 18*b* by complementary amplifier circuits each of which comprises a plurality of transistors. Transistor 41 is of the p-n-p type and is base connected by line 42 in series with resistor 43 to line 15*b*. Transistor 41 is emitter-connected by line 44 in series with resistor 45 to line 15*b*. It will be understood that resistors 43, 45 will have differing values of resistance chosen to provide the proper bias voltage for transistor 41. Transistor 46 is of the n-p-n type and is base-connected by line 47 to receive the collector voltage of transistor 41. Line 18*b* is series connected by lines 48, 49 and diodes 50, 51 to receive the collector voltage of transistor 46.

Transistor 52 is also of the n-p-n type and is base-connected by lines 53, 54, diodes 55, parallel-connected with by-pass resistor 55*a* to line 47 to receive the collector voltage of transistor 41. Transistor 52 is emitter-connected to line 15*b* by lines 56, 57 and series-connected resistor 58 to provide desired voltage to the emitter.

Transistor 59 is base connected by line 60 to receive the emitter voltage of transistor 52. Transistor 59 is of the p-n-p type and its emitter is series-connected by resistor 61 and line 56 to line 15*b*. The collector of transistor 59 is series-connected to line 18*b* by resistor 62.

Transistor 63 is of the n-p-n type and is base-connected by line 64 to receive the collector voltage of transistor 59. The emitter of transistor 63 is connected by line 65 to line 15*b*, and its collector is series-connected to line 18*b* by resistor 66. Connected to lines 57 and 60 and in parallel with resistor 58 is a line 67 including diodes 68.

Transistors 59*a* and 63*a* are similarly connected between lines 14*b* and 18*b* with corresponding connected lines, resistors, and diodes bearing a like number with the suffix *a*. However, in the case of the transistors, where transistor 59 is of the p-n-p type, transistor 59*a* is of the opposite type, that is n-p-n type. Similarly, transistor 63 is of the n-p-n type and transistor 63*a* is of the p-n-p type.

Additionally, transistor 52 and transistor 52*a* are of opposite types, the former being of the n-p-n type and the latter being of the p-n-p type. Transistor 52*a* is base-connected in series with resistor 69 which in turn is connected to line 18*b*. Line 70 interconnects the collector of transistor 52 with the emitter of transistor 52*a*.

Transistor **41***a* is of the n-p-n type, opposite from that of transistor **41**, and is base-connected by lines **71**, **72** and in series with resistor **73** to line **15***b*. The emitter of transistor **41***a* is connected by lines **48***a*, **74** to the base of transistor **52***a*. The collector of transistor **41***a* is series-connected by line **75** and resistor **76** to line **14***b*.

As noted heretofore, a variable frequency signal is superimposed upon direct current signals. The superimposed signal is received by transistor **80** which is base-connected to line **71** with its collector series-connected to line **14***b* by resistor **81**. Transistor **80** is of the n-p-n type and its emitter is interconnected with the collectors of transistors **82**, **83** by line **84**.

Transistors **82**, **83** are both of the n-p-n type. Transistor **82** is base-connected to ground, and its emitter is series-connected to line **15***b* by resistor **43** and line **85**. Similarly, the emitter of transistor **83** is series-connected to line **15***b* by resistor **43***a* and line **86**. Transistor **83** is base-connected to terminal **12***a* for receiving the variable frequency signal from line **12** by line **12***b* and resistor **87** which may be variable, if desired.

While particular embodiments of the invention have been illustrated and described, various changes and modifications can be made without departing from the invention and it is intended in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What is claimed is:

1. An electrostatic wand for the relief of pain upon contact with tissue structure comprising

walls of electrically-insulating material forming an enclosure having therein an elongate evacuated cavity, and

an electrically-conducting member extending through said enclosure walls and having one end portion disposed within one end of said cavity and

having a second end portion terminating externally of said walls and adapted to be connected to a source of electropositive electrical voltage pulses of the order of about 12,000 to about 15,000 volts and at variable frequencies in the range of about 300 to about 1,000 megacycles per second,

said walls having a tissue-contacting external surface positioned opposite said one end of said cavity capacitively coupling said variable frequency pulses to ground potential when said surface is in contact with tissue structure,

mirror surfaces within said cavity at opposite ends thereof and adjacent said conducting member and said external surface respectively,

an annular member of electrically conducting material slidably disposed within said cavity for reciprocation therein,

means electrically connecting said annular member to said conducting member, and

means slidably mounted externally of said walls for reciprocation thereon and concomitantly selectively positioning said annular member,

wherein said cavity is evacuated to a pressure of about 28 mm. of Hg. below atmospheric pressure and said cavity contains an inert gas at a pressure of about 1 mm. of Hg. absolute.

2. A wand according to claim **1** and additionally including means magnetically coupling said annular member with said externally mounted slidable means.

3. Structure according to claim **1** wherein said mirror surfaces are spaced apart a distance about one fourth of the wavelength corresponding to the frequency at the lower end of said frequency range.

4. Structure according to claim **3** wherein said distance is in the range from about 7 centimeters to about 25 centimeters.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,785,383 Dated January 15, 1974

Inventor(s) Gianni A. Dotto

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet, in the heading, item [73] should read as follows: -- Assignee: 1/2 to Alfred A. Anglemyer, Dayton, Ohio --.

Signed and sealed this 18th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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