

Aug. 9, 1938.

F. C. WAPPLER

2,126,070

ELECTROTHERAPY

Filed April 29, 1932

Fig. 1

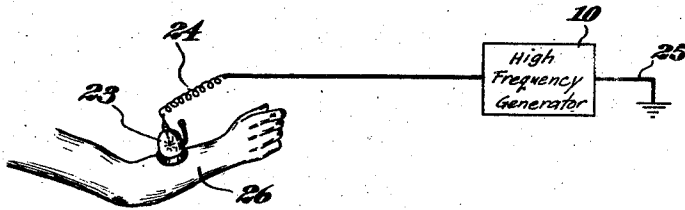


Fig. 2

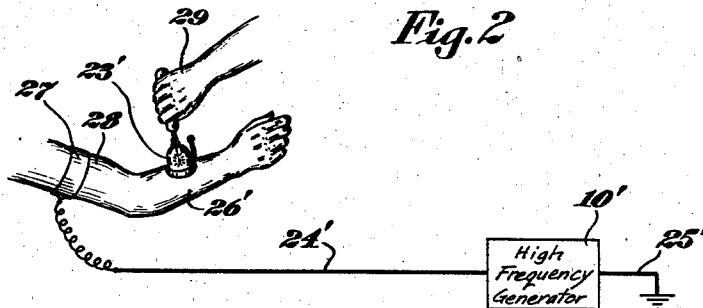


Fig. 3

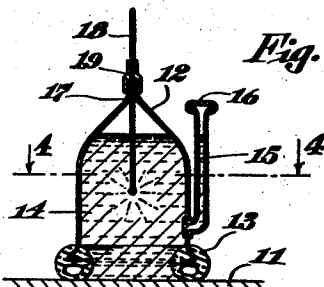


Fig. 5

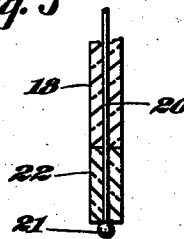


Fig. 4

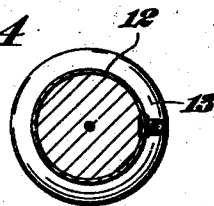
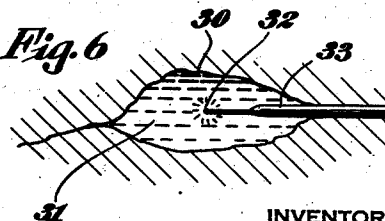


Fig. 6



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2,126,070

ELECTROTHERAPY

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Application April 29, 1932, Serial No. 608,192

8 Claims. (Cl. 128—172.1)

My present invention relates generally to electro-therapy, and has particular reference to a novel and unique method of subjecting portions of the human body, both exterior and interior, to certain novel therapeutic effects.

The art of electro-surgery and electro-therapeutics, in so far as the employment of sustained high-frequency alternating current is concerned, is veritually in its infancy, and yet the advent of improved means for feasibly and economically enabling surgeons and doctors to generate alternating currents of safe low voltage and sustained oscillations of relatively high frequencies has given rise to extremely rapid developments in the new techniques involved. So little is known of the remarkable characteristics and capabilities of high-frequency alternating currents, especially as to the effects which such currents may be caused to produce in connection with therapeutics, that the established surgical and medical art can hardly be relied upon as a guide or prognosticator of the apparently remarkable and unique results that seem to be capable of accomplishment by the newly developed types of high-frequency currents.

My present invention, for example, is predicated upon the discovery that the generation or formation of a disruptive high-frequency arc within the body of a conductive fluid is accompanied by phenomena which have proven to have new and highly beneficial capabilities from the standpoint of therapeutics. It is, accordingly, a general object of my present invention to provide a new technique which involves the therapeutic application to the human body of fluids in which a disruptive arc of this character is generated.

I have found, for example, that the formation of an arc within a fluid with which medicaments are associated has peculiar and often inexplicable effects in liberating or releasing the medicaments or similar active elements. Accordingly, by applying a mass of such fluid to the portion of the human body which is to be treated, coincidentally with a formation of a disruptive high-frequency arc therein, it is possible in a new and unique and highly effective manner to liberate such medicaments in intimate contact with the body and under conditions producing a definitely ascertainable, effective penetration of the medicaments into the body.

By means of my present invention, I am enabled to provide a new and effective method of medicating or similarly treating interior portions of the body which have heretofore been wholly

inaccessible. The walls of interior cavities may, for example, be subjected to the medicating and other beneficial effects of my present mode of procedure by filling the cavities with the proper current-conductive fluid and causing a disruptive arc in the fluid to produce its effects.

In producing or forming a disruptive arc of the character hereinbefore mentioned and capable of producing the beneficial effects sought to be accomplished, it is a feature of my invention to employ a current-concentrating electrode in combination with a generator or source of suitable high-frequency current whose sustained low voltage high-frequency output of power is sufficient to generate a sustained disruptive arc beneath the surface of the fluid in which the electrode is immersed.

I have found that the electrode may itself under certain circumstances be caused to incorporate medicaments or active elements which are adapted to be released under heat, as a result of which the generation of an arc of the character mentioned causes these active materials to be released, apparently in colloidal condition. My invention thus has further recourse to the well known phenomenon whereby colloids are caused to move at a rapid rate away from a rupturing arc, and I am enabled by my present invention to produce colloids in situ and simultaneously drive them with penetrative effect against the cavity wall or other body portion which is under treatment.

Further effects of a rupturing arc of the present character lie in the production or generation of an intense light, coupled with a highly effective vibratory effect which lends itself readily to beneficial therapeutic use. Whether such vibration is due to a bombardment of the body portion by minute bubbles or particles of gas, or of minute particles of suspended colloidal matter, or both, or whether it is due in some other way to certain stresses which are set up in the fluid by the disruptive arc, I am not enabled at this time to state. Extensive experimentation has demonstrated, however, that at least a part of the remarkable vibratory effect which is produced by an aqueous solution in which the arc is formed is due to the rapid generation and forceful propulsion through the liquid of minute particles or bubbles of pure or nascent oxygen, a phenomenon which readily suggests some of the extremely beneficial effects which a therapeutic procedure of the present character may be caused to produce.

One of the main features of my invention, 55

which greatly enhances its utility and facilitates the practice thereof under a variety of conditions, is based upon the discovery that a disruptive arc of the present character may be produced without necessarily establishing what would ordinarily be referred to as a complete electrical circuit. Where a proper type of high-frequency generator is used, for example, I have found that an electrical connection between only one terminal of such generator, on the one hand, and either the immersed electrode or the body under treatment, on the other hand, is sufficient to produce the desired effects. Where a connection is made with the electrode, for example, it appears that most of the energy, or at least a large portion of it, is used up at the arc itself and in the production of the accompanying phenomena, the remainder of the energy entering the body under treatment being dissipated or radiated from this body very much as energy is radiated or dissipated from a broadcasting antenna. Similarly, where an electrical connection is made with the patient, usually at some convenient exterior area, I have found that it is utterly unnecessary to connect the immersed electrode with the high-frequency source, and that the disruptive arc may be produced and maintained, despite such utter disconnection of the immersed electrode from any other portions of the apparatus. The energy is in this instance dissipated or radiated through and by the body of an operator grasping the electrode. The advantages of this mode of carrying out the effects of my invention need hardly be elaborated upon, but it may be stated by way of example that in the generation of a disruptive arc in a fluid which is contained within a body cavity, the disconnected nature of the electrode from any wires or leads is of tremendous value not only in facilitating the procedure itself but also in the design and manufacture of surgical instruments for insertion into body cavities.

Other features and advantages of my invention, and of its almost innumerable possible ramifications will be more fully appreciated after this specification has been read. For illustrative purposes, I have shown in the accompanying drawing one manner of carrying out my present invention. In the drawing—

Figure 1 is a perspective view of the arm of a patient showing, by way of illustration, how my present mode of electro-therapy may be applied to the forearm;

Figure 2 is a view similar to Figure 1 showing an alternative procedure;

Figure 3 is a more detailed elevational cross-section through one illustrative type of apparatus for applying a current-conductive fluid to a portion of the body;

Figure 4 is a cross-sectional view taken substantially along the line 4-4 of Figure 3;

Figure 5 is an enlarged cross-sectional view of one type of current-concentrating electrode; and

Figure 6 diagrammatically illustrates the manner in which my present invention may be employed to subject internal cavities to certain treatments.

The current which I employ in connection with my present invention is an alternating current of high frequency, the voltage being relatively low and sustained and the amount of current being a variable factor which depends partly upon the size of the area being treated, partly upon the tolerance of the patient, and partly upon the

conditions under which the disruptive arc is to be generated. The source of this current may be of any suitable character which complies with the necessary requirements, and has not been illustrated herein in detail, being represented diagrammatically at 10 and 10'. Merely by way of example, a high-frequency current generator of the character described in my earlier Patent Number 1,962,796 will furnish the current necessary. It will be understood that the amount of current or energy available is sufficient to permit the desired arc to be formed and sustained, and that the frequency is sufficiently high to bring the current well within the range of present-day electro-therapeutic and electro-surgical high frequencies. Wherever the term "high-frequency" is used herein and in the appended claims, it is intended to refer to high-frequency alternating current of this character.

In Figures 1 and 2, I have illustrated two alternative methods of practicing my invention in connection with the therapeutic application of the current, and of the effects produced by a rupturing arc of the present character, to the forearm of a patient. In each case, a vessel or similar suitable instrumentality is adapted to be applied to the body portion to be treated in a manner whereby a current-conductive fluid may be maintained in contact with the area to be subjected to the treatment. In Figures 3 and 4, I have shown, merely by way of illustration, the general type of vessel or apparatus which might be used for this purpose.

In Figure 3, if 11 be assumed to represent the forearm or other portion of the body, the vessel 12 may, for example, be of glass or the like and of substantially circular or other suitable cross-section, and at its lower edge it may advantageously be provided with a pneumatic rim 13 preferably of rubber or the like. The vessel is adapted to accommodate the current-conductive fluid which may, for example, be a liquid electrolyte 14; and the apparatus shown is illustrative of one possible arrangement whereby the joint is made fluid-tight and whereby the fluid or liquid 14 is caused to remain in sustained contact with the portion 11.

The vessel 12 may be filled and emptied in any suitable manner, and I have illustratively shown the possibility of arranging an inlet and outlet tube 15 which may be normally capped, as at 16, by any suitable closure.

I have shown the vessel 12 with an attenuated upper end or neck 17 through which a current-concentrating electrode member 18 may be arranged to extend, preferably in a removable manner, for example, by the employment of a rubber nipple 19 or the like. The member 18 is so constructed that only a relatively small and attenuated end portion thereof is uninsulated and adapted to be immersed within the current-conductive fluid or liquid 14. In the illustrated form, I have shown the member 18 as a hollow or tubular rod which accommodates an electric lead wire 20 therein. The rod is made of insulation, such as rubber, and the portion near the operative current-concentrating electrode 21 may be advantageously constructed of quartz or similar vitreous material, as indicated at 22.

The electrode 21 may have any suitable shape or configuration, and need not necessarily be spherical, as herein illustrated. It is, however, relatively small, preferably no larger than the head of a large-size pin or the like, so that the current passing therethrough will be sufficiently

concentrated to generate a disruptive arc around this electrode when the latter is inserted into a current-conductive fluid. In Figure 1, I have shown a vessel 23 of the general character illustrated, by way of example, in Figures 3 and 4, and I have shown a lead wire 24 connecting the immersed electrode with the high-frequency generator 10. The latter may be assumed to be grounded, as at 25. Without any further connections to the generator 10, it is not only possible but highly practical and feasible to generate a disruptive arc of this present character in whatever fluid is accommodated in the vessel 23, as a result of which the desirable therapeutic effects of the present invention are produced upon the forearm 26 or other area with which the conductive fluid is in contact. Without endeavoring to give a full explanation of the phenomenon, since it is not fully understood by me, it is my theory, supported by tests and experiments, that most of the energy from the generator 10 is expended at the immersed electrode, and that the remainder of the energy passes into the arm 26 and is radiated by the body of the patient.

The same desirable effects may be produced as indicated in Figure 2 wherein the generator 10' grounded as at 25', has one terminal thereof connected as at 24' with a contact member or plate 27 secured to the body of the patient, as, for example, to the upper portion 28 of his arm. A vessel 23', preferably of the character hereinbefore described, is applied by a person other than the patient to the forearm 26' as before, but the immersed electrode is entirely disconnected from the generator 10', and in fact there is no connection whatsoever between the vessel 23' or any parts associated therewith and the generator 10'. If the electrode member 18 is suitably constructed so as to be graspable by the hand 29 of an operator, as indicated in Figure 2, the desired disruptive arc will be generated and sustained, as before, despite the utter disconnection of the electrode from the source of current. The theory hereinbefore advanced serves to explain this phenomenon, and it is my belief that most of the energy is expended at the electrode and the remainder of it surges upwardly through the electrode into the hand 29 and thence into the body of the operator, where it is radiated.

In Figure 6, I have illustrated this highly advantageous characteristic or possibility of my present invention, in so far as the treatment or medication of interior portions of the body is concerned. I have diagrammatically illustrated an illustrative internal cavity 30 which is caused to be filled with a suitable current-conductive fluid 31. Connection is established between a suitable high-frequency generator, as in Figure 2, and a suitable accessible portion of the body of the patient. An electrode 32 is then caused to be immersed in the fluid 31, as, for example, by insertion into the cavity through an endoscopic tube 33 or the like. If the rear end of this electrode is grasped by an operator, a disruptive arc is formed in the fluid 31, and all the desirable effects of my present invention are accomplished in intimate proximity with the walls of the cavity 30, despite the fact that neither the operator nor the electrode 32 is at all connected with the source of high-frequency current.

Highly beneficial and desirable effects are produced, as hereinbefore stated, when medication is associated with the current-conductive fluid in which the arc is formed. One method of accomplishing this is to form the fluid of a liquid elec-

trolyte with which the medicament or medicaments have been associated. The range of possibilities is so varied that only a few will be herein specified for illustrative purposes. For example, an argyrol aqueous solution may be employed, in which case the present invention and the formation of a disruptive arc in this solution will liberate the argyrol and cause it to penetrate into whatever body portion is in contact therewith. The term "penetration" is not employed in a mere figurative sense, since it has been clearly demonstrated that an actual penetration may be effected, and that the penetration is carried out to a far greater extent than that which has heretofore been possible by ordinary-direct application of the medicament. This penetration is apparently due in some way to the peculiar effect of the disruptive arc upon the fluid in which it is immersed, possibly because of a disruptive effect upon the constituency of the fluid, possibly because of some liberation or precipitation of the medicament under the action of the heat or current or both, or possibly because of some sort of combination of such effects. In the case of argyrol, which is a colloid of silver, it may be that the effect is produced by the capability of the current or arc to drive the colloid forcefully away from the arc, thereby causing the silver to be driven with force against the tissue and into the latter. The valuable medicative effects of silver are, of course, well known.

Where potassium iodide is employed, iodine has been clearly shown to be thrown down by the generation of the present disruptive arc, and the penetration of this element into the tissue has obvious advantageous effects. Other medications that might, for example, be employed with equal and similar advantages are mercuric potassium iodide, salts of uranium such as uranium nitrate, bicarbonate of soda, ordinary salt, boric acid or its salts, silver nitrate or other salts or compounds of silver, and other compounds of similar medicative character.

In the case of uranium salts, the effects produced by my present invention may cause the compound to decompose and liberate either the pure uranium or compounds of the latter, the radioactive character of which at once suggests the extremely valuable possibilities of my invention in connection with the treatment of tumors and the like. It will be understood, however, that the characteristics of my present process are so varied, and its effects upon the human body of its various phases are so little known at the present time, that I cannot at this time specifically attribute any particular advantage or effect to any particular feature or group of features of the invention.

In some instances, the generation of the disruptive arc has an effect upon the immersed electrode itself, gradually wearing it away and causing its constituents to be forced into the fluid. Accordingly, the electrode itself may in many instances be advantageously caused to incorporate medicaments of the character herein discussed. For example, the electrode may be composed of pure silver, platinum, tungsten, arsenic, or the like, or of compounds of such substances, for example, amalgams, under which circumstances the material itself or the medicaments associated therewith are adapted to be liberated, probably by virtue of the extreme heat, and are forced into colloidal suspension in the liquid, thereafter being forcibly directed away from the arc and into penetration into the tissue.

Where the disruptive arc is generated beneath the surface of a liquid, it manifests itself by an aura of sparks surrounding the electrode, and by the development of extreme bubbling, and intense light, and a strong vibration which produces standing waves upon the surface of the liquid. These phenomena lend themselves readily to the production of brand new therapeutic effects, and these are capable of accomplishment either alone or in combination with the advantages hereinbefore mentioned. For example, intense light has well-recognized therapeutic advantages, especially in combination with the application of heat, warmth and heat being capable of generation in the tissue by the passage of the current itself. Similarly, the vibratory effect, which is probably due to some unique type of bombardment of the submersed body portion, and appears to be due to a bombardment of minute particles of nascent oxygen where the arc is formed in an aqueous solution, has marked beneficial massaging effects; and these effects are obviously of great advantage and benefit, especially in conjunction with the medicative effects hereinbefore mentioned. Under certain circumstances, nascent chlorine appears to be liberated, and if it should develop that the vibratory effect is actually due to a bombardment of minute gas particles, the liberation of such a gas, or of a number of other gases which different conductive fluids may give rise to, has obvious beneficial effects.

Although I prefer to use a liquid electrolyte, it will be understood that a gaseous fluid may be employed, as, for example, neon or the like, the electric disruptive arc having the possible effect of producing still further therapeutic results upon the body portion which is submersed in the fluid.

So far as the capabilities of my present invention in connection with internal cavities is concerned, I will refer illustratively to one specific type of treatment which will demonstrate its remarkable utility. So-called "Hunter" ulcers in the bladder are usually treated with argyrol, but they are difficult to observe since they are embedded within the walls of the bladder. By filling this cavity with an aqueous argyrol solution or the like, as indicated in Figure 6, the practice of my present invention may be caused to subject every minute area of the bladder wall to the medicative, and other, effects herein mentioned.

So far as I am aware this mode of treatment of the bladder, or, for that matter, of any interior cavity, for diathermic or medicative purposes, is entirely novel and unique.

Although I have mentioned some of the possible beneficial effects of the phenomena resulting from the generation of a disruptive high-frequency arc in a conductive fluid, it will be understood that so little is known of the human body and of its reactions, and so little is known of the exact nature of the phenomena which the high-frequency current produces under the conditions herein described, that in many cases it is not possible to definitely state whether the beneficial effects are produced by the heat or warmth, by the passage of the current itself, by the impregnation with medication, by the vibratory effects produced, by the bombardment of tissue with gases or particles, by the dissociation of the conductive fluid, by the effect of the arc upon colloids, or by the intense light which is produced. In all probability, many of the effects are the result of combinations of these phenomena, and

it will be understood that the application of my invention to specific instances will have specific results and particular advantages which will depend largely upon the particular requirements and circumstances of each case.

Regardless of the causes or reasons for the results attained, it appears that the characterizing feature of my invention lies in the formation and sustention of a disruptive high-frequency arc beneath the surface of a current-conductive fluid, preferably, though not necessarily, a liquid; and preferably, though not necessarily, a liquid with which medicaments are associated, as, for example, in solution, in suspension, or incorporated with the current-conductive electrode itself. Furthermore, I deem it of particular importance to be enabled by my invention to produce these effects and to form the desired disruptive arc by a single connection to a suitable source of high-frequency current, either by connecting the source directly to the electrode and permitting the energy to be radiated by the patient, or by connecting the source with the patient and permitting the energy to be radiated by the operator.

In general, it will be obvious that changes in the details herein described and illustrated for the purpose of explaining the nature of my invention may be made by those skilled in the art without departing from the spirit and scope of the invention as expressed in the appended claims. It is therefore intended that these details be interpreted as illustrative, and not in a limiting sense.

Having thus described my invention, and illustrated its use, what I claim as new and desire to secure by Letters Patent, is:

1. The herein-described method of liberating medication in intimate contact with an interior cavity of the human body, which consists in filling said cavity with a current-conductive fluid with which the medicament is associated, immersing only a single current-concentrating electrode in said fluid at a distance from the wall of said cavity, and generating a high-frequency alternating current disruptive arc in said fluid at said electrode.

2. The herein-described method of subjecting the walls of an interior cavity of the human body to vibrations, which consists in filling said cavity with a current-conductive liquid, immersing a current-concentrating electrode in said liquid at a distance from the walls of said cavity, and generating a high-frequency alternating current disruptive arc in said liquid at said electrode.

3. The herein-described method of subjecting the walls of an interior cavity of the human body to intense light for therapeutic purposes, which consists in filling said cavity with a current-conductive fluid, immersing a current-concentrating electrode in said fluid at a distance from the walls of said cavity, and generating a high-frequency alternating current disruptive arc in said fluid at said electrode.

4. The herein-described method of liberating medication in intimate contact with an interior cavity of the human body and simultaneously subjecting the walls of said cavity to vibrations and intense light, which consists in filling said cavity with a current-conductive liquid with which the medicament is associated, immersing a current-concentrating electrode in said liquid at a distance from the walls of said cavity, and generating a high-frequency alternating current disruptive arc in said liquid at said electrode.

5. The herein-described method of liberating

medication in intimate contact with a portion of the human body, which consists in submersing the body portion to be treated beneath a current-conductive fluid with which the medicament is associated, immersing a current-concentrating electrode in said fluid at a distance from the submersed body portion, establishing an electrical connection between said electrode and a source of high-frequency current, the latter being sufficiently large to generate a disruptive arc in said fluid at said electrode, and permitting the body under treatment to remain entirely disconnected from said source and to radiate the energy fed into it through said electrode and fluid.

6. The herein-described method of liberating medication in intimate contact with a portion of the human body, which consists in submersing the body portion to be treated beneath a current-conductive fluid with which the medicament is associated, immersing a current-concentrating electrode in said fluid at a distance from the submersed body portion, establishing an electrical connection between the body under treatment and a source of high-frequency current, the latter being sufficiently large to generate a disruptive arc in said fluid at said electrode, and causing

the energy fed into said electrode through said fluid to be radiated by an operator grasping said electrode and entirely disconnected from said source.

7. The herein-described method of liberating medication from a current-conductive fluid with which the medicament is associated, which consists in immersing only a single current-concentrating electrode in said fluid, and generating a high-frequency alternating current disruptive arc in said fluid at said electrode, whereby the walls of an interior body cavity filled with said fluid will be subjected to intimate contact with the liberated medication.

8. The herein-described method of liberating medication in a current-conductive fluid, which consists in immersing only a single current-concentrating electrode in said fluid, said electrode incorporating a medicament adapted to be released under heat, and generating a high-frequency alternating current disruptive arc in said fluid at said electrode, whereby the walls of an interior body cavity filled with said fluid will be subjected to intimate contact with the liberated medication.

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