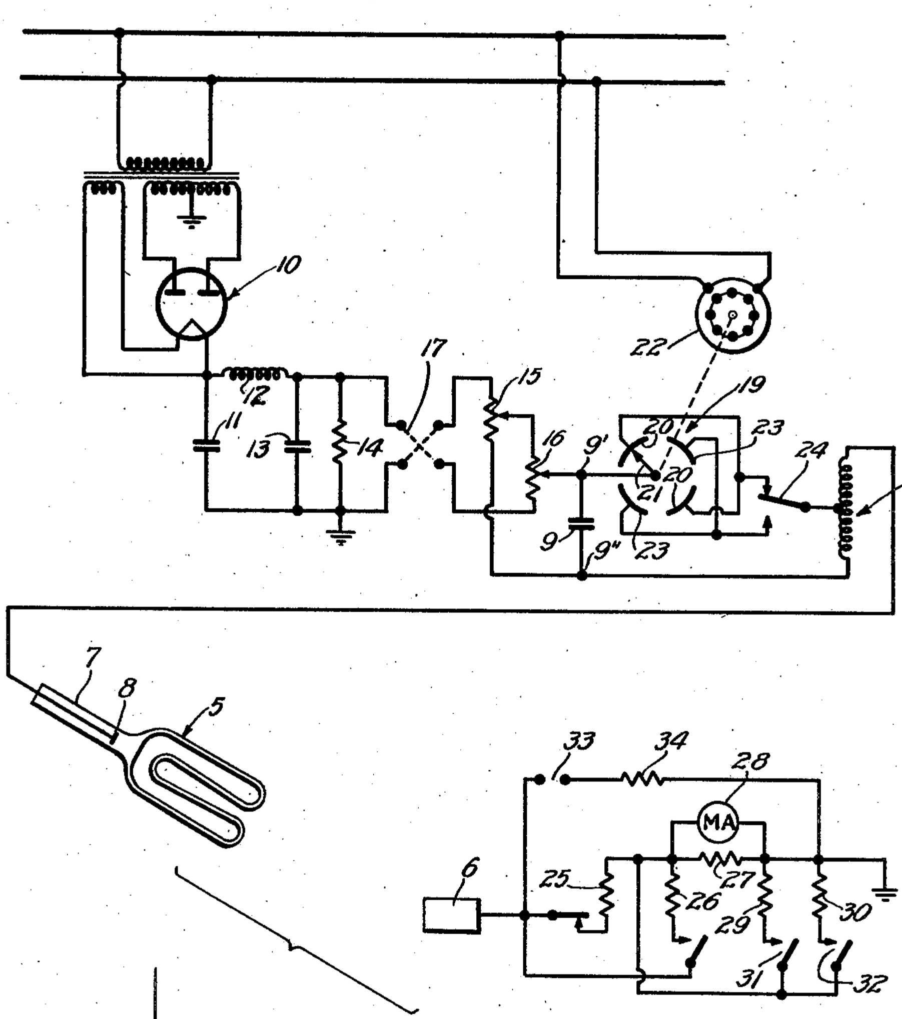
June 9, 1953 J. BATROW 2,641,259

ELECTROPHYSIOTHERAPY APPARATUS

Filed Oct. 5, 1948 2 Sheets-Sheet 1

FIG. I.



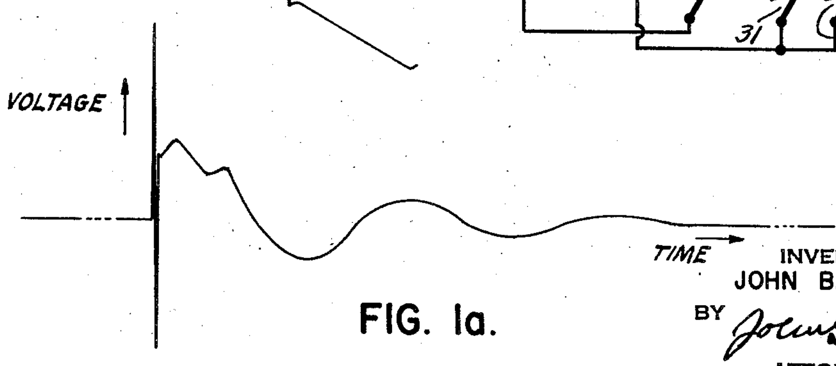


FIG. Ia.

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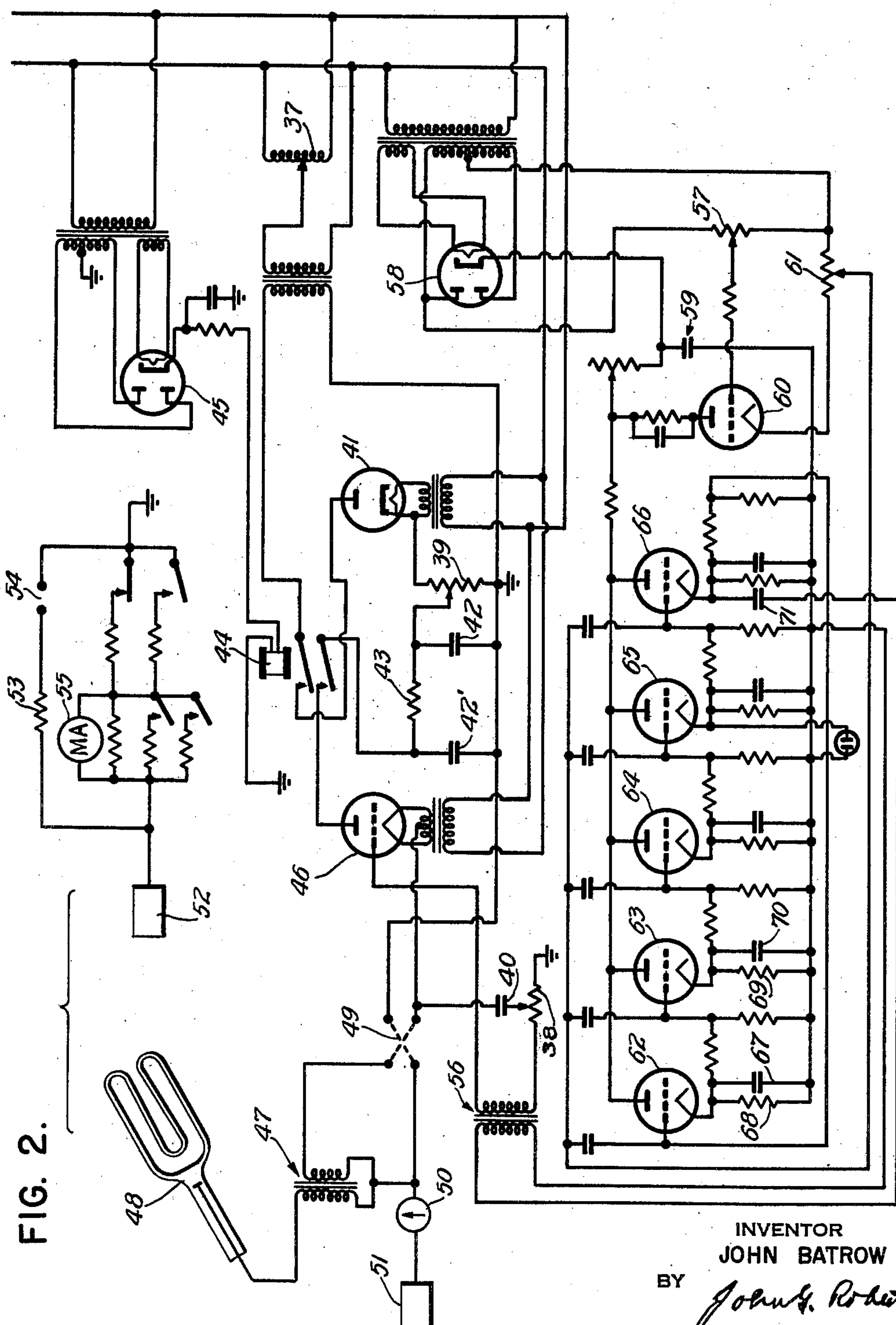

FIG. 2.

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ELECTROPHYSIOTHERAPY APPARATUS

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Application October 5, 1948, Serial No. 52,845

5 Claims. (Cl. 128—423)

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This invention relates to electro-physiotherapy, and this application is a continuation-in-part of my application, Serial No. 577,296, filed February 10, 1945. This application discloses circuit improvements not disclosed in said application Serial No. 577,296, now abandoned.

It is the general object of the invention to provide improved means to check for pathology and for correcting the cause when determined.

It is another object to provide improved nerve-stimulating means that may excite nerves at a repetition rate that is below the normal impulse rate of nerve action, whereby the excited nerve may have time to recover between successive excitations, the rate being sufficiently fast to accomplish results within a reasonable time.

It is a further object to provide an improved electro-therapy apparatus which may utilize relatively high voltages for nerve excitation and which may, nevertheless, be applied with complete safety to the human body more or less regardless of the area of close contact with the skin and also more or less regardless of the sweat condition of the skin.

It is still another object to provide an improved electro-therapy apparatus relatively steep-walled initial surges or pulses of current may be induced in a body so that relatively deep penetration of the electrical impulses may take place.

Other objects and various further features of the invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, preferred forms of the invention:

Fig. 1 is a schematic diagram of an electro-physiotherapy apparatus embodying principles of the invention;

Fig. 1*a* graphically illustrates the time variation of voltage, characteristic of a wave train produced by the apparatus of Fig. 1; and

Fig. 2 schematically shows alternative apparatus incorporating features of the invention.

My improved equipment is designed to excite, stimulate or modulate upon the nervous system of the body. While the complete physical process of such stimulation and modulation has not yet been established to the satisfaction of all, it is possible that the process in accordance with which my improved equipment is believed to affect the body may be based upon one or more of the following premises:

1. That cellular membrane behaves like man-made electric condensers, and that the membrane capacitance is very high.

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2. That myoneural junctions and synaptic connections between neurons are poled or directional in conduction of excitations.

3. That chemical status of cells or organs is determined by the hydrogen-ion concentration.

4. That the autonomic nervous system is the regulating mechanism which maintains ionic balance of cells, or hydrogen-ion concentration.

5. That when the pH of cells or tissue is minus, the cellular membranes, or electrical condensers, are charged negatively; when the pH is plus, the cellular membrances are charged positively.

6. That when these membranes, or condensers, are charged, the organs and tissues are in a negative electrical state and, when discharged, they are in a positive electrical state.

7. That many diseases with metabolic disturbances are the result of this negatively charged or positively charged condition of cells, tissues, and organs; when there is a feeling of well being, the anabolic and catabolic phases of metabolism are regulated within physiological limits as indicated by basal metabolic-rate instruments.

8. That the autonomic nervous system consists of two major branches—sympathetic and parasympathetic; the sympathetic system positively changes the organs (catabolic action), and the parasympathetic system negatively charges the organs (anabolic action).

9. That both branches of the autonomic nervous system are antagonistic to one another in action; the frequency of charge or discharge of the cells, tissues, and organs must be at a rate so as to overcome the antagonistic action of the nerve-causing disturbance.

10. That this antagonistic action manifests itself in the living, and not then if one is under the influence of drugs or other inhibitors; therefore, what is the proper frequency is based on this fact.

11. That the indication of overcharge negatively results in hypersensitivity, and overcharge positively results in hyposensitivity; the action potential must be varied to meet the status quo of the nerve or nerves stimulated.

12. That the current flow and the current density at the skin must be of relatively low amplitude to avoid burns, shocks, or other unpleasant sensations.

My improved equipment therefore includes improved means essentially for the purpose of effecting the charging negatively or the charging positively, as may be required, of cellular membranes of the human body, which cellular membranes, as indicated above, behave after the manner of man-made condensers.

My improved equipment is constructed and arranged to bias the membrane condensers as to polarity and to return them to that state required for normal health, or at least to attempt the alleviation of a given pathological condition. Novel indicating means may be employed to assist in making the necessary determinations.

Referring to Fig. 1 of the drawings, my invention is shown in application to a mechanically interrupted system for applying pulse excitations to the body between a pair of electrodes **5—6**. One of the electrodes **5—6** may be a gas-filled discharge device having an envelope of non-conducting material and for direct application to the body. In the form shown, the electrode or applicator **5** is such a gas-filled discharge device and is shown to comprise a relatively extensive winding of non-conducting tubing, such as glass tubing, communicating with a handle portion **7**. A single electrode **8** may be supported within the handle portion **7**, and the entire device may be filled with an ionizable inert gas, such as neon, under relatively low pressure. The other body-contact electrode may be a metal plate, either for direct contact as by clamping to a given part of the body, or for use as a platform on which the patient may stand.

As indicated generally above, the means for stimulating a body by the electrodes **5—6** may include a capacitor **9** that is suitably charged. In the form shown, the equipment is designed to operate from a source of alternating current; the charging means for capacitor **9** may therefore include full-wave rectifier means **10** with suitable smoothing elements **11**, **12**, and **13** to apply a smoothed direct-current potential across a load resistor **14**. Potentiometer means **15—16** may be employed for adjusting the magnitude of direct-current utilized to charge the capacitor **9**, and in order to provide for the selective reversal of polarity of this charge, there may be a reversing switch **17** between the resistor **14** and the capacitor **9**.

In accordance with the invention, the capacitor **9** is intermittently discharge through suitable differentiating means for application of pulses (characterized by relatively sharp upswings or leading edges) across the body-contact electrodes **5—6**. The differentiating means may be a step-up transformer, such as the autotransformer **18**, and the capacitor **9** may be directly connected to the primary of the autotransformer **18** through a mechanical contactor or interrupter **19**. The contactor **19** may include a pair of opposed conductive segments (connected to each other) to be contacted periodically by a continually rotating contact finger **21**, and the finger may be driven by a motor **22**. The contactor **19** may include two further opposed conductive segments **23**, which are also connected to each other and which may be selectively utilized instead of the segments **20**, depending upon the selected positioning of a switch **24**.

It will be understood that with the frequent contacting called for by operation in accordance with the invention, the discharge of capacitor **9** may be accompanied by such surges as to draw arcs between finger **21** and segments **20**. Such arcs may pit the surfaces of segments **20** and thus impair their reliability of operation. The life of a contactor such as the contactor **19** may then be extended by shifting the switch **24** so as to employ segments **23** (in place of segments **20**) for the discharge of capacitor **9**.

The single electrode **8** of the gas-discharge device **5** may be connected to one side of the secondary of transformer **18**, and the secondary circuit may be completed through the body to ground, as through a number of selectively insertable resistances **25—26—27** between the electrode **6** and ground. For purposes which will later be clear, the resistances **25—26—27** form part of what I term a meter or indicator circuit to be employed for quantitive diagnostic and pathological purposes. This meter circuit is shown to include a current-responsive device **28** which may be merely an ammeter bridging the resistance **27**, and the effective resistance of the element **27** may be reduced as desired by selectively inserting further shunt resistances **29—30**, as by operation of switches **31—32**. The meter circuit is completed by a further branch including a spark gap **33** and a resistor **34**, bridging the rest of the described meter circuit between the electrode **6** and ground.

In operation, the patient may stand upon the electrode **6** with preferably bare or with stocking feet, and the manually manipulable electrode or applicator **5** may be applied to certain parts of the body, depending upon the organ to be treated or examined, as will later be clear.

The capacitor **9** is normally charged and, as soon as the contact finger **21** contacts one of the conducting segments **20**, there may be a direct connection to the primary of the transformer **18** so as to cause an immediate low-resistance discharging of the capacitor **9**. The transformer **18** will be understood to provide not only a vastly increased step-up in magnitude of voltage, as compared with the voltage discharged from capacitor **9**, but also in effect to differentiate the wave form of the discharge from capacitor **9**. Since the discharge represents a sudden break, the differentiated output appearing in the secondary of the transformer **18** may be characterized by relatively high-voltage surge that may attain its maximum amplitude in a relatively short time. Actually, this first surge is merely the beginning of a highly damped oscillatory wave train (see Fig. 1*a*) that is repeatedly produced once for every discharge of the capacitor **9**. The meter circuit may provide the principal component of the high resistance responsible for fast damping, thereby rapidly making available a relatively long quiescent period, in order to permit a certain amount of nerve recovery before application of the next succeeding stimulation impulse.

Since the capacitor **9** is charged with direct-current of a given polarity, it will be appreciated that the initial surge of the output of transformer **18** will be of a polarized sense that reflects the polarization of capacitor **9**. Thus, if the terminal **9'** is charged to a potential greater than that of terminal **9''**, the initial surge in the secondary of the transformer **18** may be negative with respect to ground (i. e. image or reverse of the wave form of Fig. 1*a*). On the other hand, with the reversing switch **17** thrown, the potential at terminal **9''** will exceed that at terminal **9'**, and the differentiated output appearing in the secondary of transformer **18** may include an initial positive (with respect to ground) surge for each discharge operation of the interrupter **19** (as in Fig. 1*a*).

As indicated generally above, it is not known what mechanism produces the beneficial results of the invention, but it is thought that the relatively rapid initial polarized voltage surge in the output of the transformer may be able to cause electrical penetration within the body where a more slowly rising wave would otherwise be blocked by polarization effects in the nerves. The rapid rise of current transmitted to the body may also be made possible by the non-linear impedance properties of the gas-discharge applicator **5**. When excited sufficiently to render the gas conductive, the conducting gas and the fluids within the body become, in effect, opposite plates of a capacitative coupling element in the secondary circuit (which includes the body); the glass of electrode **5** and the skin of the body constitute the dielectric of the capacitative coupling. The capacitance of this coupling may present a relatively low impedance to the very high frequency components of the initial surge of the stimulating wave train.

It has been indicated generally above that my preferred repetition rate for the successive discharging of capacitor **9** is 10 to 20 per second. In practice, a repetition rate of 12 or 13 per second has been found to produce very satisfactory results. These interruption rates will be observed as being less than the normal impulse rate of nerve action, which is from 40 to 100 per second. This fact suggests that my apparatus may permit the nerve sufficient time to recover between successive applications of current surges, and that my preferred rate is rapid enough to accomplish results before the stimulating effect of each pulse may have been completely dissipated.

In Fig. 2, I show a modified form of the invention in which completely electric means are employed not only for the generation of stimulating impulses but also for periodically discharging a capacitor **40**. The means for charging the capacitor **40** may employ half-wave rectifier means **41** in conjunction with smoothing elements **42—42′—43**, and the voltage output of rectifier **41** may be controlled by a variable transformer **37**. For the protection of the system I prefer that ample time be allowed for the filaments of the vacuum tubes to warm up prior to initiating the normal operation of the system. To this end, full voltage cannot be applied across the rectifier **41** until operation of a delayed-action starting relay **44**. The relay **44** may be energized by an indirectly-heated full-wave rectifier **45**, as when emission becomes established in rectifier **45**; and, of course, the solenoid of relay **44** will thereafter remain energized as long as the required voltage is applied to the system.

In the form shown in Fig. 2, I employ a gas-discharge device, such as a thyratron **46**, periodically to apply to capacitor **40** the charging voltage from the circuit of rectifier **41**, and then to cut off the application of such charging voltage in order that capacitor **40** may discharge into the primary circuit of an output transformer. Upon firing the thyratron **46**, it will be understood that the cathode of thyratron **46** will be at the high anode potential, so that the full voltage output of rectifier **41** (as modified by the setting of potentiometer **39**) may be applied across capacitor **40** and across a small part of a bias potentiometer **38**. Due to the high capacitance of capacitor **40**, there may then be such a surge of charging current as to produce a quenching or cut-off voltage in bias potentiometer **38** for almost immediately quenching the firing of thyratron **46**; when thyratron **46** is

thus cut off, capacitor **40** may discharge directly into the primary of transformer **47**.

The secondary of the transformer **47** may include a connection to a manually manipulable gas-filled applicator **48**, which may be generally similar to the applicator **5** described in connection with Fig. 1. Again, reversing-switch means **49** may serve to reverse polarity of the capacitor discharge as it is applied to the primary of transformer **47**, thus providing a means for control of the direction of the initial surges of the wave trains generated in the secondary circuit of transformer **47**. If desired, meter or indicator means **50** and a further body-contact electrode **51** may be included in the secondary circuit of the transformer **47**. Alternatively, it may be preferred to employ a meter circuit as described in connection with Fig. 1; such a meter circuit may employ a body-contact electrode **52** connected to ground, on the one hand, through a resistor **53** and spark gap **54** and, on the other hand, through a meter **55** associated with a plurality of adjustably selectable resistances.

Operation of the switching means **46** for periodically discharging the capacitor **40** may employ any desired technique that provides periodic control or firing impulses for the grid circuit of the thyratron **46**, as via the coupling transformer **56**. In the form shown, I assume a source of alternating current having a frequency of n cycles per second, and I employ a cascaded frequency divider of x stages, such that n/x may provide the desired repetition rate of discharging capacitor **40**. It will be recalled that this desired rate is of the order of 10 to 20 per second; for the 60 cycle case, therefore, a five-stage frequency divider may provide a desired excitation rate of 12 per second.

The frequency divider of Fig. 2 may operate from a full-wave rectifier **58**, which may provide through its cathode circuit a suitable "B" supply for a pulse-generating tube **60**, and which through one of its anode circuits may provide bias control for the grid of tube **60**. By suitable adjustment of the bias resistor **57**, a single short triggering impulse (i. e. one for every full cycle of the supply voltage) may be applied to the control electrode of tube **60**. The tube **60** will thus be rendered conductive once every cycle of the supply voltage. For each such conduction of tube **60** there may be a control impulse or surge derived from a potentiometer **61** in the cathode circuit of tube **60**, for direct application to each of the tubes **62—63—64—65—66** of the five-stage frequency divider.

The load of each of the tubes **62** to **66** may be in its particular cathode circuit and, from left to right in the sense of drawing, each cathode load resistor of each tube is coupled to the grid of the next-succeeding tube stage. Each of the cathode circuits of the switching tubes **62—66** may be bridged by a capacitor, such as the capacitor **67** across the load resistor **68** in the circuit of tube **62**, so that upon conduction of a switching tube, such as the tube **62**, the voltage appearing across its load resistor (**68**) may charge its load capacitor (**67**). The charge on capacitor **67** may be held sufficiently long to maintain a reduced bias on the control grid of the next-succeeding tube stage **63**, so that upon generation of the next pulse (corresponding to the next cycle of the supply voltage), as derived from potentiometer **61**, there may be a starting of tube **63** to the exclusion of the other tubes **62, 64, 65,** and **66**. Upon conduction of tube **63**, the voltage appearing across the load resistor 69 is available to charge capacitor 70 for appropriate reduction of the bias on the control grid of the next succeeding stage 64; and, of course, the next succeeding impulse may be effective to operate the tube 64 to the exclusion of the other switching tubes 62, 63, and 65, 66.

In like manner, tubes 65 and 66 will be successively operated for the next two succeeding cycles of the supply voltage; and, upon conduction of the last stage 66, a control impulse may be fed to the primary of the coupling transformer 56, as through a coupling capacitance 71, for the controlled firing of thyratron 46 and, hence, for the generation of a wave train for application to the body between electrodes 48 and 51 or between electrodes 48 and 52, depending upon the connections employed. The switching or tube-triggering sequence may be rendered self-recycling by coupling the cathode-circuit output of tube 66 back to the control grid of the first switching stage 62, as will be clear. It will thus be seen that for every timing impulse supplied to the thyratron 46, there will have been five successive operations of the various stages of the frequency divider and that these stages will have been operated by five successive cycles of the supply voltage. For a 60-cycle supply, the thyratron 46 will thus be fired at a repetition rate of 12 per second.

As indicated generally above, it is not known exactly what mechanism is involved when a body is placed between the manually manipulable gas-filled applicator (5, 48) and one of the other body-contact electrodes. It is known, however, that the wave train generated upon each discharge of a capacitor (9, 40) is characterized by an extremely steep-walled initial surge of voltage to a relatively high magnitude and that this surge is followed by a highly damped oscillation which decays after some 6 or 8 swings; the frequency of the swings may be from 2,000 to 5,000 cycles per second, depending upon the inductance capacitance constants of the step-up transformer (18, 47) and of various other elements in the circuit; and, upon the first half-cycle of this oscillation, there always appears to be superimposed a further highly damped oscillation of higher frequency (at least 6 or 8 times the characteristic 2,000 to 5,000 cycles per second). As far as is known of the pulse characteristics of my device, it is preferred that the rise time of the principal-pulse output shall be of the order of 50 microseconds, with a rise to 75 percent of the peak of this pulse in an interval of the order of 20 microseconds. It is known that the preferred repetition rate of 12 per second (or at least between 10 and 20 per second) is below the normal impulse rate of nerve action; for these rates, a preferred duty cycle of the order of 10^{-3} is thus indicated. By "duty cycle" is meant the fractional relation between the time duration of the principal-output pulse and the time interval between successive principal-output pulses. It is known that a gaseous-discharge applicator, such as the applicators 5 and 28, may provide a convenient means of applying current to the body, due to the substantially purely capacitance characteristics of these applicators when so applied to the body; these characteristics make possible current distribution more or less independent of the area of close contact with the skin and more or less independent of the sweat condition of the skin, since the skin itself is subjected to little or no actual flow of current.

The nature of current conduction within the body is admittedly obscure, particularly when capacitatively subjected to the short high-peaked pulses produced by applicant's equipment. However, the following is believed to be well-established:

a. A nerve-cell membrane is a rectifier with a limiting resistance for outward current flow of approximately $1/100$ that for inward flow.

b. A healthy nerve is a chain of cells, each of which has properties resembling an electric oscillating circuit, with a self-contained source of E. M. F.

c. A finite, but relatively short, interval of time is required in which to excite a nerve; this interval of time will depend upon the magnitude of the applied signal (the greater the applied signal, the shorter the time for excitation); once excited, the response of the nerve is substantially the same, more or less regardless of the amplitude of the applied signal; and, once excited, the nerve exhibits an "absolute refractory period" followed by a "relative refractory period," during which time a repetition of the same applied signal will have no excitative effect on the nerve.

d. The electrical resistance of a nerve, in the conductive direction, and for the period after signal application and before excitation, is low, very much lower than skin resistance, even much lower than the resistance of sweaty or otherwise wetted skin.

e. Nerves, or at least the nerves of present concern, terminate at the skin; and particular nerve systems terminate at particular points at the skin (i. e. at particular parts over the body).

In use, the body under treatment may be inserted directly between a manually manipulable applicator (5—48) and one of the other body-contact electrodes (6—51—52); alternatively, the operator may grasp one of the electrodes, say, the manually manipulable electrode (5—48) while the patient stands on or is otherwise in contact with the other electrode (6—51—52). The operator may then use his fingers or hand to contact the desired parts of the patient's body, thus interposing parts of his own (the operator's) body in the secondary circuit of the apparatus.

In using my improved equipment, the referred-pain method of diagnosis is employed. Referred pains can only be understood when the organ is carefully studied with reference to its embryologic development, in which case it will be seen that the usual visceral pain follows the segmental relationship which determined the innervation in early development life. Head's clinical investigations are of practical importance and have been verified and are often used with my improved equipment. Below are listed some of Head's charted areas of important organs, which have been verified with my improved equipment:

Heart—cervical 3, cervical 4, dorsal 2 to dorsal 8;
Lungs—cervical 3, cervical 4, dorsal 4 to dorsal 9;
Stomach—dorsal 7 to dorsal 9;
Intestines—dorsal 9 to dorsal 12;
Liver—cervical 3, cervical 4, dorsal 7 to dorsal 10;
Kidney—dorsal 11 to lumbar 1;
Bladder—sacral 3 to sacral 4.

The above listing is helpful in illustrating diagnostic use of the invention in visceral neurology. The visceral organs have previously been shown (by Head, inter alia) to be served by particular nerve systems, and in each of these nerve systems there is an afferent nerve (viz.

sympathetic nerve, corresponding to a sensory nerve for the skeletal system) and an efferent nerve (viz. parasympathetic nerve, corresponding to a motor nerve for the skeletal system). According to visceral neurology, each viscus is connected with the surface of the body through afferent (sympathetic) nerves. When a viscus is diseased, the threshold of response in these nerves (serving this particular viscus) is lowered, so that under various stimuli the areas connected with that viscus show pain more readily than they ordinarily would; such pain has been termed a "referred pain." The present invention is, in effect, a nerve modulator (i. e. it will stimulate via a nerve), and when applied to these areas in which the threshold is lowered, the system of the invention will produce pain when it does not affect adjacent areas supplied by nerves from other spinal segments. By so stimulating these areas, the system of the invention effects a change in nerve action in the viscus itself. With a knowledge of the viscera, and of the skin-terminated nerve systems associated with each particular viscus, it will be clear that one may diagnose a particular visceral abnormality and that one may therapeutically stimulate the abnormal viscus.

Now the above chart lists nerve systems of the character above-discussed, serving certain vicera. The term "cervical 3" will be understood to refer to the third cervical nerve (of which there are eight on each side of man). The cervical nerves branch out from the upper or neck portions of the vertebra; the dorsal or thoracic nerves branch out from the vertebra below the cervical nerves; the lumbar nerves branch out below the dorsal nerves; and the sacral nerves branch out from the lower portions of the vertebra.

Specifically, and to illustrate, if the heart of the patient is in a pathologic state, we find that the patient will feel pain when the manually manipulable electrode 5 or when the operator's finger is placed on the skin ending of the cervical-3 nerves. As will be seen from the above listing, this will not be a conclusive diagnosis, because the heart, lungs, and liver are all served by the cervical-3 nerves. However, it will be noted that no two organs are served by the same combination of nerve systems, and that therefore the illustrated referred-pain method may serve for a definite identification of the abnormal organ.

The theory upon which my treatments are based is the reciprocal reflex relationship which exists between dermal or somatic and visceral or splanchnic structures. This reciprocal relationship is closer than is generally realized. For many years, physicians have attempted to treat visceral disease by applications to the surface of the body. The study of pathologic physiology gives us definite basis for such therapeutic measures, especially when using the proper electrical modulation upon the nervous system.

After locating the organ responsible for the causes of the disease by the diagnostic method outlined above, and also after taking advantage of the existing methods of checking to verify the findings when possible (methods such as blood count, urine analysis, X-ray and fluoroscope study, etc.), the procedure is to affect the organ or organs through the nervous system; this treatment may necessitate a particular polarized position of the reversing-switch means (17—49) depending upon the observed meter indications (on one of the meters 28-50-55), depending upon which equipment is employed). One position of the reversing switch means (17-49) may be termed a positive position (corresponding to the generation of positive initial surges of the wave trains), and the other position of the reversing-switch means (17-49) may be termed a negative position (corresponding to the generation of negative initial surges of the wave trains).

Although the phenomenon has not been identified or fully explained, it is known that for a given setting of the charge control (potentiometer 16, transformer 37), that is, for a given charge on the capacitor (9—40), and for application of the body-contact electrodes between given parts of the body, a positive meter indication may be obtained for a positive position of the reversing-switch means (17—49); in like manner, a negative meter reading may be obtained for a negative position of the reversing-switch means (17—49). Similarly, for the same instrument settings, but between different parts of the body, or for another health condition of the organs affected by contact with the same parts of the body, a negative meter reading may be obtained for a positive position of the reversing-switch means, and a positive meter reading may be obtained for a negative position of the reversing-switch means. Furthermore, depending upon the parts of the body contacted, and depending upon the condition of the organ thereby under examination, a given adjustment of the charge-control means (16—37) may result in changing a positive meter reading to a zero reading, or in changing a negative meter reading to zero. The meter reading, the potentiometer settings, and the switch polarity settings may all be correlated with the healthy state of particular internal organs examined by the referred-pain method, so that upon a diagnosis any deviation from these correlated findings may indicate the health condition of the particular organ that is affected. Often this trouble or health condition will be evidenced by a referred pain which merely serves to check the meter observations. Knowing the direction in which the meter reading must be caused to change in order to produce a healthier state in a diseased organ, the method of treatment contemplates applying appropriately polarized stimulation in the above-described manner, thereby tending to effect the desired correction in the meter reading for the organ under consideration. Often, the meter indication may be visibly altered in a single treatment (indicating a corresponding improvement in the health condition of the treated organ), for with a given setting of the charge control (16—37) and with a given polarity setting of the reversing-switch means (17—49), the meter may be observed to swing from what may be termed an unhealthy indication in the direction of the expected normal or healthy indication.

The following diseases, among others, have been treated with my improved equipment under close medical supervision, with good results; multiple sclerosis; peripheral neuritis; paralysis agitans; Ménière's disease; arthritis deformans; hypertension; hypotension; hyperthyroid; hypothyroid; and osteo-arthritis.

While the invention has been described in considerable detail and preferred forms of apparatus illustrated and described, and preferred procedure indicated, it is to be understood that various changes and modifications may be made within the scope of my invention as defined in the appended claims.

I claim:

1. In an electrophysical neurostimulator of the character indicated, an electrical capacitor, means connected to said capacitor for charging said capacitor, a transformer including an input and an output, means connecting said input to said capacitor, said connecting means including switching means having a control providing a timed switching operation at the input of said transformer at a repetition rate of the order of 10 to 20 per second, and body-applicator means comprising a gas-filled tube having a dielectric envelope and an interior electrode connected to the output of said transformer.

2. In an electrophysical neurostimulator of the character indicated, an electrical capacitor, means connected to said capacitor for charging said capacitor, a transformer including an input and an output, means connecting said input to said capacitor, said connecting means including a mechanical interrupter and drive means therefor providing a timed switching operation at the input of said transformer at a repetition rate of the order of 10 to 20 per second, and body-applicator means comprising a gas-filled tube having a dielectric envelope and an interior electrode connected to the output of said transformer.

3. In an electrophysical neurostimulator of the character indicated, an electrical capacitor, means connected to said capacitor for charging said capacitor, a transformer including an input and an output, means connecting said input to said capacitor, said connecting means including electronic switching means having a control providing a timed switching operation at the input of said transformer at a repetition rate of the order of 10 to 20 per second, and body-applicator means comprising a gas-filled tube having a dielectric envelope and an interior electrode connected to the output of said transformer.

4. In an electrophysical neuromuscular stimulator of the character indicated, pulse-generator means including an electrical capacitor, means connected to said capacitor for charging said capacitor, electrical impedance means, means connecting said capacitor across at least a part of said impedance means, said connecting means including switching means having a control providing a timed switching operation at said connection to said impedance means at a repetition rate of the order of 10 to 20 per second, the rise time of the principal-pulse output of said generator means being of the order of 50 microseconds, and body-applicator means including two separate electrodes connected respectively across at least a part of said impedance means, and a dielectric envelope filled with a conductive gas electrically in series with one of said electrodes.

5. An electrophysical stimulator according to claim 4, in which the rise to 75 percent of the peak value of the principal-pulse output of said generator means is of the order of 20 microseconds.

JOHN BATROW.

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