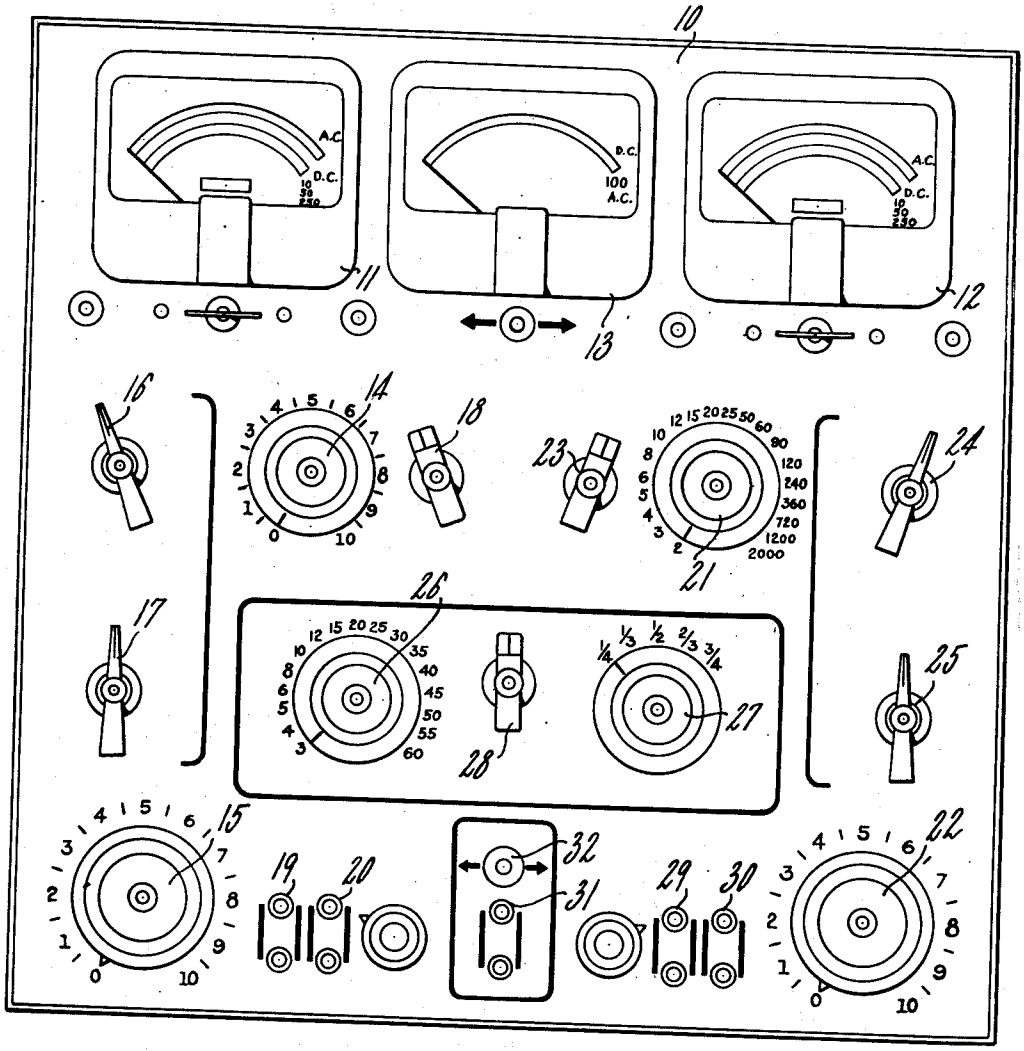
March 2, 1954 F. S. LANDAUER 2,671,176

SWITCH ARRANGEMENT FOR ELECTROTHERAPEUTIC TREATMENT PLANTS

Filed Dec. 8, 1948

5 Sheets-Sheet 1

Fig. 1



INVENTOR.
FRED S. LANDAUER
BY
Leon M. Straus
AGT

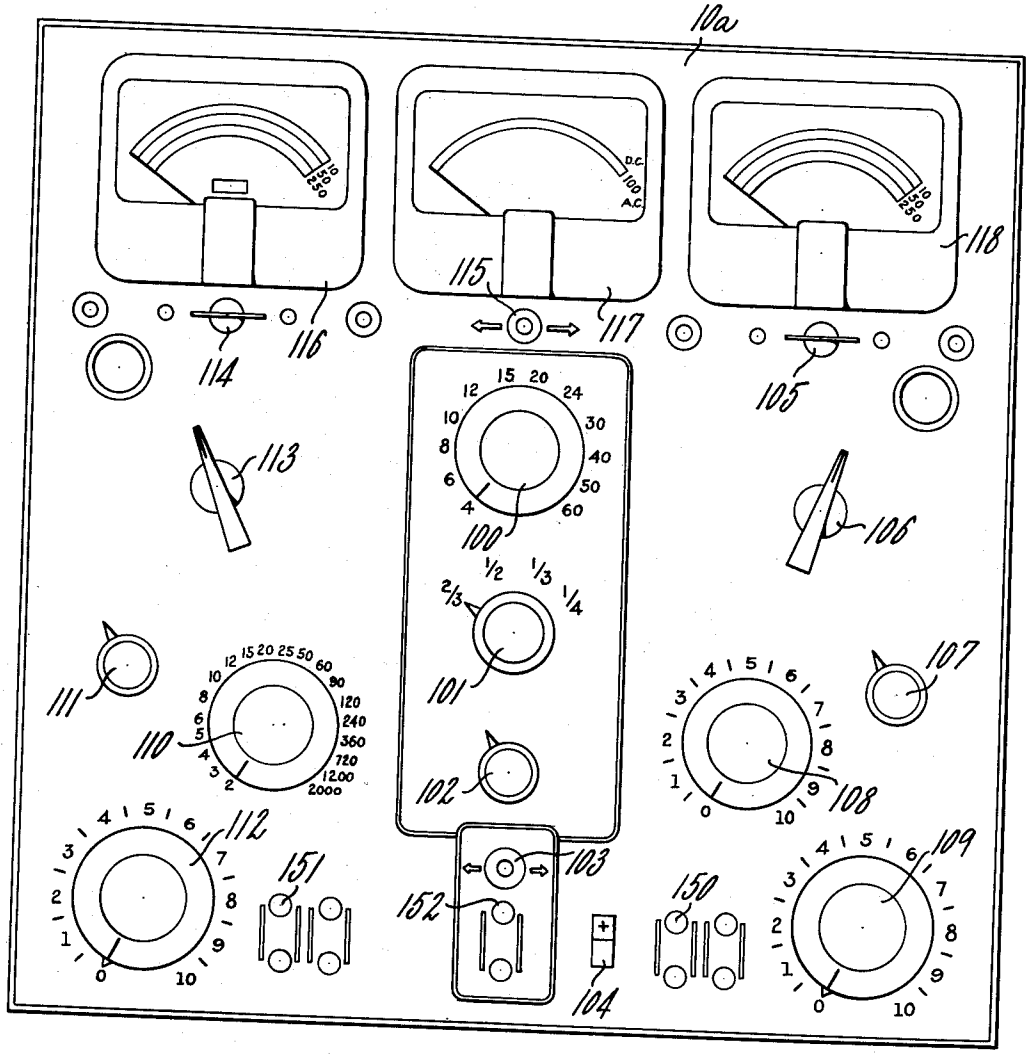
March 2, 1954 F. S. LANDAUER 2,671,176

SWITCH ARRANGEMENT FOR ELECTROTHERAPEUTIC TREATMENT PLANTS

Filed Dec. 8, 1948

5 Sheets-Sheet 2

Fig. 2



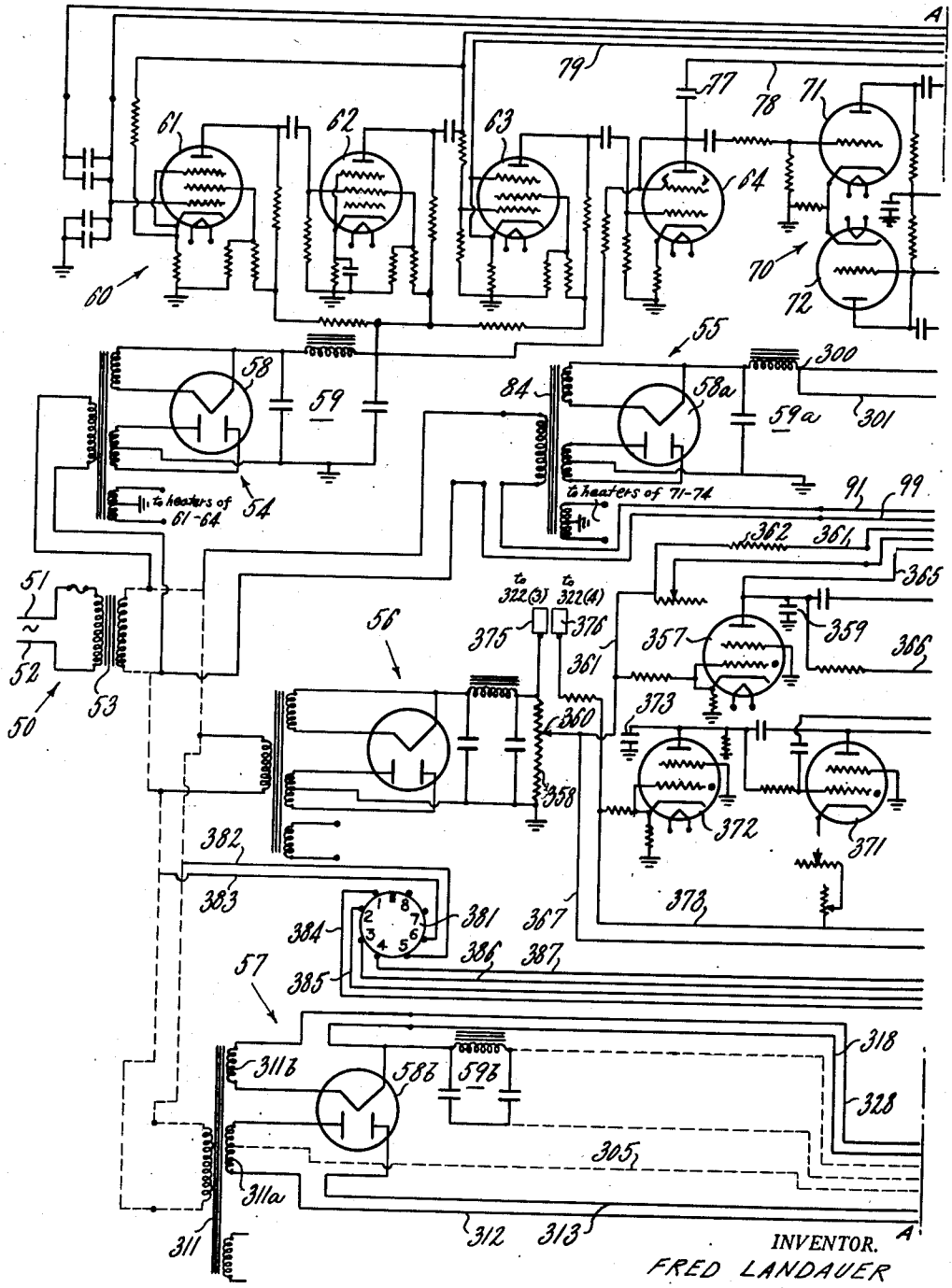
INVENTOR.
FRED S. LANDAUER
BY Leon M. Straus
Atty

March 2, 1954 F. S. LANDAUER 2,671,176

SWITCH ARRANGEMENT FOR ELECTROTHERAPEUTIC TREATMENT PLANTS

Filed Dec. 8, 1948

5 Sheets-Sheet 3



INVENTOR.
FRED LANDAUER
BY Leon M. Strauss
Atty

Fig. 3

March 2, 1954 F. S. LANDAUER 2,671,176

SWITCH ARRANGEMENT FOR ELECTROTHERAPEUTIC TREATMENT PLANTS

Filed Dec. 8, 1948

5 Sheets-Sheet 4

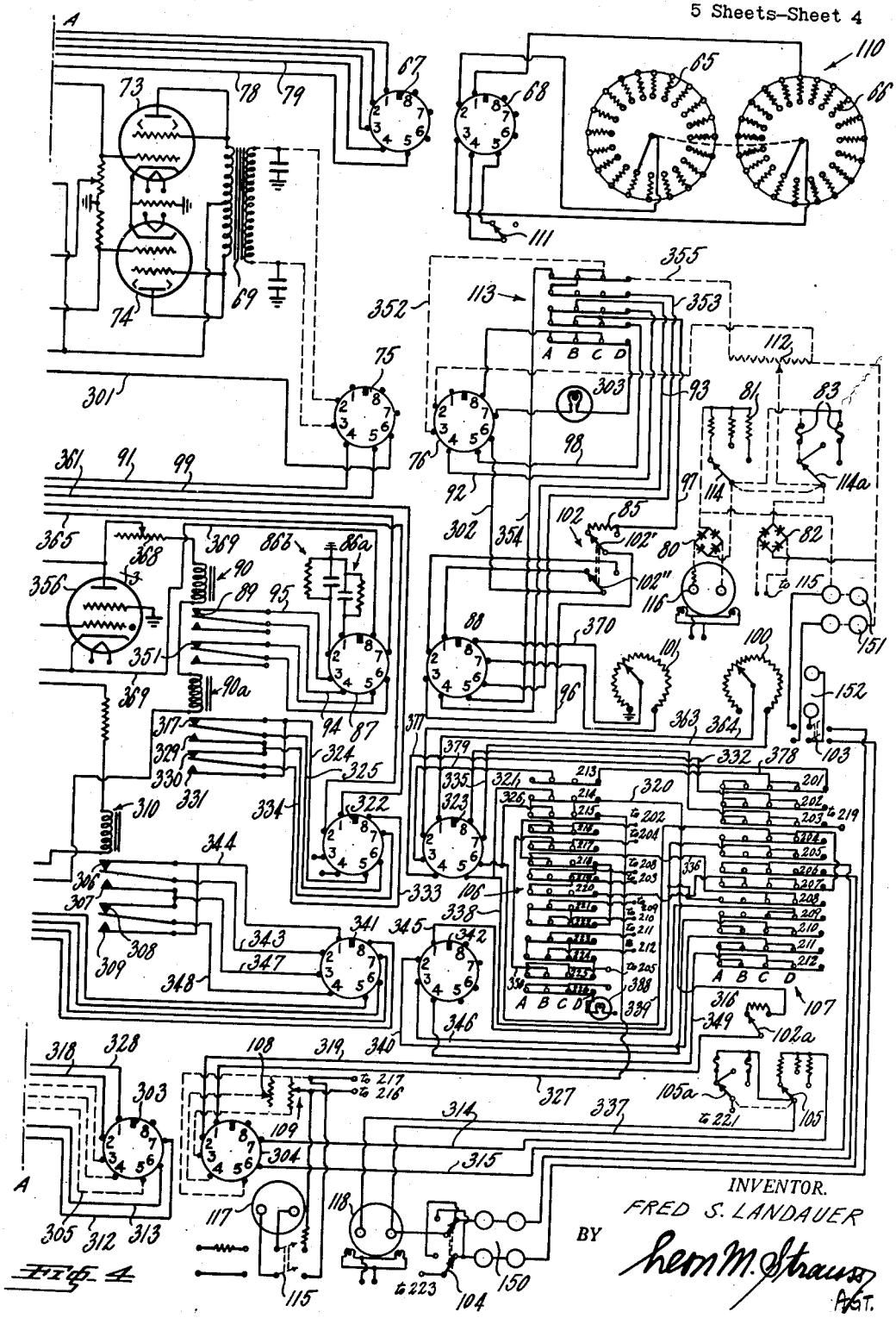


Fig. 4

INVENTOR.
FRED S. LANDAUER
BY Leon M. Strauss
AGT.

March 2, 1954 F. S. LANDAUER 2,671,176

SWITCH ARRANGEMENT FOR ELECTROTHERAPEUTIC TREATMENT PLANTS

Filed Dec. 8, 1948

5 Sheets-Sheet 5

Fig. 5

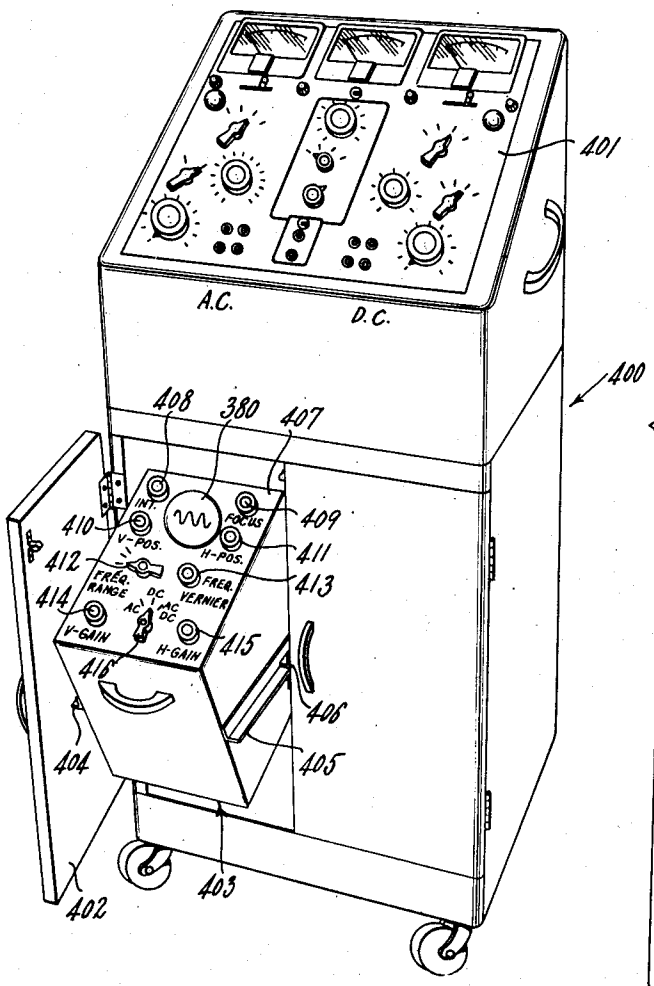
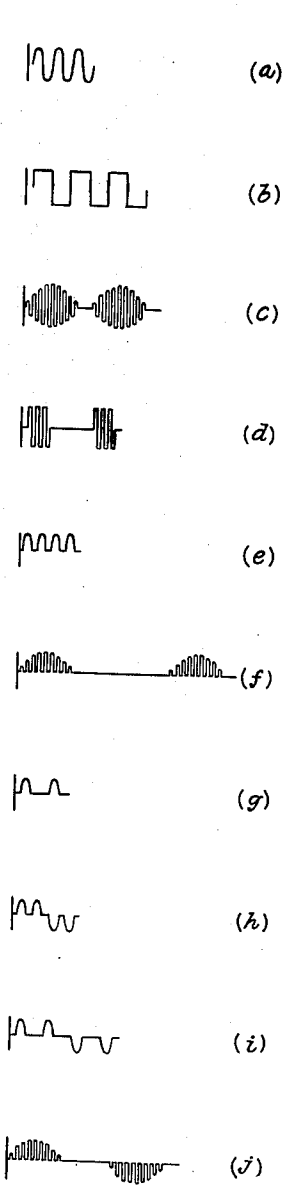


Fig. 6



INVENTOR.
FRED S. LANDAUER
BY Leon M. Strauss
ATT.

Patented Mar. 2, 1954

2,671,176

UNITED STATES PATENT OFFICE

2,671,176

SWITCH ARRANGEMENT FOR ELECTRO-THERAPEUTIC TREATMENT PLANTS

Fred S. Landauer, Rockville Centre, N. Y.

Application December 8, 1948, Serial No. 64,132

16 Claims. (Cl. 307—151)

1

This invention relates to electric treatment plants and more particularly to switch arrangements for electro-therapeutic plants or apparatus.

It is one of the objects of the present invention to provide means affording a wide range in the flexibility and latitude of current application to any desired medium for treatment purposes.

It is another object of the present invention to provide means offering the possibility of modulating electric current types before as well as during the application thereof.

It is a further object of this invention to provide means for obtaining electric shock treatment during any stage of any electric current treatment, thus bringing about a combination of various electric treatments.

A still further object of this invention is to provide means permitting observation and measuring of reactions of the patient to be treated and subjected to predetermined current intensity and voltage and facilitating comparative tests between one mode of treatment and another mode of treatment which may be administered successively or during predetermined time intervals.

Still another object of the present invention is to provide means ensuring substantially the same condition of current and its modalities for repeated use and at any time upon completion of a treatment.

Still a further object of this invention is to provide means enabling the operator, physician or the like to accomplish diagnostic work, as well as comparative tests under preset or predetermined conditions of electric current or currents.

It is still another object of the invention to provide means enabling variation in the therapeutic treatment of patients, whereby at least one basic electric current type is employed which may be combined with or on which may be superimposed further electric currents of the same or different type.

It is still a further object of the present invention to provide means permitting instantaneously and independently change of the basic current with respect to the mode of current flow, its build-up speed, and its duration of flow.

Still another object of this invention is to provide means improving the employment of at least two circuits for the treatment of a patient whereby the latter may be subjected to one current flow in one circuit while substantially the same electric current is being administered through a second circuit but in different or modulated form.

A further object of this invention is to provide a switch arrangement facilitating selection of direct current, alternating current or direct current with automatically reversing polarities.

2

A further object of the present invention is to provide means rendering the administration of electric currents possible in continuous, surging or interrupted forms.

Still a further object of this invention is to provide means enabling the operator to administer during treatment of a patient direct current either with full wave or half wave rectification.

Still another object of this invention is to provide means varying the degree of pulsation of direct current from substantially ripple-free direct current to complete unfiltered direct current.

It is a further object of this invention to provide means facilitating immediate change of alternating current from sine-wave to square-wave form and vice versa, and ensuring control of the frequency (cycles) of such alternating current.

Still another object of the present invention is to provide means enabling the selection of any predetermined number of surges or interruptions per minute during the administration or operation of the electro-therapeutic plant.

It is another object of this invention to provide means permitting the operation of a switch panel in such manner that electric current may be delivered at opposite outlets with the same intensity or with different intensities, or with the same or different intensity in surging or interrupted form.

Still another object of the invention is to provide means for regulating the number of surges or interruptions per minute by said switch panel at one and the same time, whereby two circuits with exactly the same number of surges and the same on-off periods are operated regardless whether alternating current or direct current is delivered or whether alternating current is furnished at one outlet and direct current on the opposite outlet of the switch panel.

With the above and other objects in view, the invention will be hereinafter more particularly described and the combination and arrangement of parts will be shown in the accompanying drawings and pointed out in the claims which form part of the specification.

The invention will be described in detail with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a control panel forming part of the treatment plant according to the invention;

Fig. 2 is a view similar to that of Fig. 1,

showing a slight modification of the control panel;

Figs. 3 and 4 show a single diagram of the electric circuits associated with the panel of Fig. 1 or 2, Fig. 4 forming a continuation of Fig. 3 to the right of the line A—A;

Fig. 5 is a perspective view of the plant in operative condition; and

Fig. 6 shows a plurality of graphs representative of various wave forms obtainable with a treatment plant according to the invention.

Referring now more particularly to the drawings, there is disclosed in Fig. 1 an instrument panel **10** for the operation of an electro-treatment plant. The control parts of this panel are so disposed that on the left hand side the supply of direct curent and on the right hand side of the panel the supply of alternating current may be regulated.

To this end, the panel **10** is equipped with milliampere-meters **11** and **12**, voltmeter **13** and has the following control means: a switch **14** for adjusting the pulsations of direct current, a rheostat **15** for changing the intensity of direct current, current selectors **16**, **17** respectively for changing polarity of direct current and for modifying said current to a continuous, surging or interrupted direct current. Further arranged adjacent pulsation switch **14** is a control lever **18** to vary the pulsating direct current from half wave or full wave. Terminals **19**, **20** are employed for connection with consumer units, such as electrodes (not shown) for administration of direct electric current.

The right hand side of the panel **10** carries a controller **21** for varying the frequency of the alternating current supply, the intensity switch **22**, the control lever **23** for changing the alternating current wave from square wave to sine wave and vice versa, and further the current selectors **24**, **25** of which current selector knob **24** provides for the change of polarity for direct current and modality selector knob **25** effectuates modification of the alternating current to continuous, surging or interrupted alternating current.

In order to bring about changes in the conditions of surging direct and/or alternating currents and interrupted surges per min., adjustments by means of potentiometer **26** are made whereas surge periods may be predetermined by means of regulator (potentiometer) **27**. Switch lever **28** is designed to control the surge build-up (slow or fast).

Outlets or terminals **29**, **30** are provided for connection with consumer units to be supplied by alternating or direct current.

Further outlets in the form of test terminals **31** either to be switched to the left or right side of the insrument panel (by means of control knob **32**) are provided in order to facilitate comparison tests of the selected values of direct current with that of alternating current values.

Fig. 2 shows a panel **10***a* for an electric treatment plant similar to that which can be operated by means of switch panel **10**. Switch panel **10***a* is considerably simplified with respect to switch panel **10** and reference to the respective elements appearing on switch panel **10***a* is made in the ensuing specification describing in greater detail the circuit diagram used in connection with panel **10***a*.

Referring first to the circuit diagram of Figs. 3 and 4, there is shown a power source **50** comprising a pair of alternating-current mains **51**, **52** and an input transformer **53**. The secondary of transformer **53** (which may be a step-up transformer, if desired) feeds a plurality of rectification networks **54**, **55**, **56** and **57**, each comprising a rectifier tube, such as diode **58**, and a filter, such as the condenser-choke combination **59**. Rectifier **54** supplies plate voltage to the tubes **61**, **62**, **63** and **64** of an oscillator **60** of the resistance-capacity type whose output frequency may be controlled from a switch **110** serving to connect a selected one of a plurality of resistors **65**, **66** in the feedback circuit of the oscillator, the connection between the oscillator and the switch **110** being established by way of two suitably interconnected terminal blocks or plugs **67**, **68**.

The rectifier **55** supplies plate voltage to the tubes **71**—**72** (twin triode), **73** and **74** of a push-phase inverter pull amplifier **70** which is connected to the output of oscillator-generator **60** and supplies alternating current over output transformer **69** and connectors **75**, **76** to the A.-C. terminals **151**.

Terminals "4" and "5" of connector **68** are connected to a switch **111** adapted, in the position illustrated, to close a negative feedback circuit for the oscillator **60** which can be traced from the plate of tube **64** over condenser **77**, conductor **78**, terminal **67** (at "5"), terminal **68** (at "5"), switch **111**, terminal **68** (at "4"), terminal **67** (at "4"), conductor **79** to the cathode of tube **63**.

When this circuit is closed, the tubes of the oscillator will operate on such portions of their characteristics that a sinusoidal output having the frequency selected by means of the switch **110** will be obtained at the A.-C. output terminals **151**. When, however, the switch **111** is opened, the bias of tube **63** will be varied and the oscillations modified so that square waves will be obtainable at these terminals **151**.

The amplitudes of the oscillations appearing at the A.-C. terminals **151** may be regulated by means of an intensity control switch **112** which comprises a potentiometer connected across the terminals "2" and "3" of plug **76** through the intermediary of an A.-C. control switch **113** having four banks of contacts indicated at A, B, C and D. This switch has four positions: In the first, the contacts of bank A are connected with respective contacts of bank D. This is the "interrupted current" position as more fully explained hereinafter. In the second position, the contacts of banks B and D are thus interconnected, this being the "surging current" position. In the third position, a similar connection exists between banks C and D, this being the "continuous current" position. In the fourth position the contacts of bank D are insulated, this being the "off" position.

A milliammeter **116** is inserted in the circuit from potentiometer **112** to terminals **151** and is fed rectified current from a copper-oxide rectifier bridge **80**. A switch **114** serves to connect different values of resistance **81** in shunt with the combination **80**, **116** for the purpose of varying the scale spread of the milliammeter **116**.

A selenium rectifier bridge **82** is connected across the output portion of potentiometer **112** to enable the output voltage to be measured by means of a suitable voltmeter (not shown). A switch **114***a* is provided for selectively connecting the bridge **82** to a plurality of fuses **83**.

The primary of transformer **84** which is associated with the rectification network **55**, is connectable to the upper arm **102'** of a double-throw, double-pole switch **102**, adapted either to

connect this primary directly across the secondary of input transformer 53 or (in the position of the switch illustrated) to insert a resistance 85 in series therewith. Switch 102, which controls the build-up of surges in a manner more fully described below, also has a lower arm 102'' which serves to complete the filter 59a, associated with network 55, by connecting one of two condenser-resistor combinations 86a, 86b as the second shunt arm of this filter.

The first of these circuits exists only when the switch 113 stands in its second or "surging" position and includes terminals of a pair of connectors or plugs 87, 88 as well as contacts 89 of an interrupter relay 90; this circuit can be traced from the primary of transformer 84, conductor 91, terminal 75 (at "4"), terminal 76 (at "4"), conductor 92, switch contacts of banks 113 (at "D") and 113 (at "B"), conductor 93, terminals 88 (at "4") and 87 (at "4"), conductor 94, closed contacts 89, conductor 95, terminals 87 (at "3") and 88 (at "3"), conductor 96, switch arm 102', conductor 97, contacts of banks 113 (at "B") and 113 (at "D"), conductor 98, terminals 76 (at "5") and 75 (at "5"), conductor 99 back to secondary of transformer 53.

The second of these circuits may be traced from terminals 300 of network 59a, conductor 301, terminals 75 (at "6") and 76 (at "6"), conductor 302, switch arm 102'', terminal 88 (at "1") or 88 (at "2"), terminal 87 (at "1") or 87 (at "2"), network 86a or 86b, to ground. This circuit is independent of switch 113.

Terminals "7" and "8" of plug 75 may be connected to any convenient source of power (not shown) for the purpose of energizing a lamp 303 when the switch 113 is in any of its three operative positions.

The output of the alternating-current branch of the plant described above, and of the direct-current branch presently to be described, may be selectively obtained from the test terminals 152 by connecting the same over a double-throw, double-pole switch 103 either to the A.-C. terminals 154 or to the D.-C. terminals 150.

Terminals 150 are energized from terminals 221, 223 of a current selector switch 106 which is similar to the switch 113 in the A.-C. branch, the current being supplied to terminals 216, 217 of switch 106 from an intensity control rheostat or potentiometer 109 which corresponds to the potentiometer 112, the output portion of potentiometer 109 being placed across a voltmeter 117 by way of a double-pole, double-throw switch 115; the latter switch also serves to connect the voltmeter 117 to the A.-C. branch through meter rectifier 82 (connections not shown).

Switches 105, 105a in the meter shunt network correspond to switches 114, 114a, respectively, and a milliammeter 118 is connected in parallel with switch 105 in similar manner as are millliammeter 116 and switch 114. A polarity switch 104 is inserted just ahead of the D.-C. terminals 150.

The potentiometer 109 is connected across the output of network 57 by way of a pair of connectors 303, 304. The network 57 comprises a filter 59b which is connected to the anode return conductor 305 of the associated rectifier tube 58b by way of a potentiometer 108, representing a pulsation control. When the slider of potentiometer 108 is in its top position (as viewed in Fig. 4), there will be a short circuit between the filter 59b and conductor 305 and the filter will be fully effective (no resistance being present) to smooth the output of tube 58b. In every other

position of the switch 108, a greater or less amount of resistance will be in series with the shunt arms of the filter, thus lessening the effect of the latter so that a more or less unsmoothed, pulsating direct current will be obtained.

In the preferred embodiment of the invention described, a continuous, surging or intermittent output may be obtained from either the A.-C. branch or the D.-C. branch of the plant, under the control of selector switches 113 and 106, respectively. In the D.-C. branch, however, means have been provided for permitting further variations by utilizing either half-wave or full-wave rectified current and for periodically reversing the polarity of the surges if surging current is to be produced.

For this purpose an additional D.-C. current control switch 107 is associated with switch 106, switch 107 having five banks indicated at A, B, C, and D corresponding to four operating positions. Positions I and II are for unipolar output whereas positions III and IV connect contacts 306, 307, 308 and 309 of a polarity reversing relay 310 in series with the output circuit, this relay being periodically operative in a manner subsequently described.

In positions II and IV band D of switch 107, the connection between the right-hand anode of tube 58b and a secondary 311a of transformer 311, associated with network 57, is open at conductors 312, 313, so that only half-wave rectification will take place; in positions I and III (A and C) full-wave rectification is effected by short-circuiting conductors 312, 313 over a circuit that can be traced from conductor 312, terminals 303 (at "7"), 304 (at "7"), conductor 314, contacts of bank 107 (at "A") or 107 (at "C"), contact 206 of bank 107, conductor 315, terminals 304 (at "6") and 303 (at "6"), back to conductor 313.

A surge build-up switch 102a, preferably ganged with switch 102, is connected in the filament circuit of tube 58b for the purpose of selectively introducing a resistance 316 in series with the secondary 311b of transformer 311.

This circuit leads over contacts 317 of interrupter relay 90 by way of connectors 322, 323 and can be traced from the filament of tube 58b, conductor 318, terminals 303 (at "2") and 304 (at "2"), conductor 319, switch 102a, conductor 320, contact 214 of bank 106 (at "D"), contact of bank B of the switch 106 in position II, conductor 321, terminals 323 (at "5") and 322 (at "5"), conductor 324, contacts 317, conductor 325, terminals 322 (at "6") and 323 (at "6"), conductor 326, contact of bank 106 (at "B"), contact 215, conductor 327, terminals 304 (at "1") and 303 (at "1"), conductor 328, back to secondary 311b.

When the switch 106 is in position I or III, conductors 318, 328 will be short-circuited at contacts 214, 215 through strappings provided between corresponding contacts of banks 106 (at "A") and 106 (at "C").

The lower set of contacts 317, 329, 330 and 331 of relay 90a acts as polarity reversing contacts for interrupted (non-surging) current when the switch 106 stands in position I and switch 107 stands in position III or IV.

In that case the D.-C. output circuit may be traced from contact 216, associated contact of bank 106 (at "A"), contact 202, associated contact 107 (at "C") or 107 (at "D"), conductor 332, terminals 323 (at "8") and 322 (at "8"),

conductor 333, contacts 330 of energized relay 98a, conductor 334, terminals 322 (at "7") and 323 (at "7"), conductor 335, contacts of bank 107 (at "C") or 107 (at "D"), contact 203, contact 219, associated contact in bank 106 (at "A"), contact 208, associated contact in bank 107 (at "C") or 107 (at "D"), conductor 336, contact in bank 106 (at "A"), contact 218, contact 222, contacts in bank 106 (at "A"), contact 221, switches 105a, 105, conductor 337, upper arm of switch 104, terminals 150, lower arm of switch 104, contact 223, contacts in bank 106 (at "A"), contact 224, contact 225, associated contact in bank 106 (at "A"), contact 205, associated contact in bank 107 (at "C") or 107 (at "D"), conductor 339, terminals 323 (at "5") and 322 (at "5"), conductor 324, contacts 317, conductor 325, terminals 322 (at "6") and 323 (at "6"), conductor 339, contact of bank 107 (at "C") or 107 (at "D"), contact 204, contact in bank 106 (at "A"), to contact 216.

A somewhat similar circuit, including connectors 341, 342 as well as the aforementioned contacts of relay 310, exists when selector switch 106 is in position II (surging); this circuit extends from contact 216, contacts of bank 106 (at "B"), contact 218, contact 222, associated contact in bank 106 (at "B"), contact 210, associated contact in bank 107 (at "C") or 107 (at "D"), conductor 340, terminals 342 (at "2") and 341 (at "2"), conductor 343, contacts 308 of energized relay 310, conductor 344, terminals 341 (at "1") and 342 (at "1"), conductor 345, contact of bank 107 (at "C") or 107 (at "D"), contact 209, contact in bank 106 (at "B"), to contact 221 and back from contact 223, associated contact in bank 106 (at "B"), contact 211, associated contact in bank 107 (at "C") or 107 (at "D"), conductor 346, terminals 342 (at "3") and 341 (at "3"), conductor 347, contacts 308, conductor 348, terminals 341 (at "4") and 342 (at "4"), conductor 349, contact of bank 107 (at "C") or 107 (at "D"), contact 212, contact in bank 106 (at "B"), contact 224, contact 225, associated contact in bank 106 (at "B"), conductor 350, contact in bank 106 (at "B"), to contact 217.

It will thus be seen that, when switch 106 is in position I, the contacts of relay 90a interrupt the output circuit of the D.-C. branch, whereas, when switch 106 is in position II, these contacts interrupt the filament circuit of tube 58b. Interruption of the filament circuit will result in a discontinuous flow of current in the output of network 57, the discontinuity taking the form of surges due to the thermal inertia of the filament.

In perfectly analogous manner, when switch 113 stands in position I, the relay 90 at its upper contacts 89 interrupts the filament circuit of tube 58a included in the network 55, this interruption taking place in the primary circuit of the transformer 84 as previously described. Finally, the relay 90 is provided with contacts 351 which, when the switch 113 stands in position II, are included in the output circuit of the A.-C. branch over a circuit leading from terminal 76 (at "3"), conductor 352, contacts of banks 113 (at "B") and 113 (at "A"), contact of bank 113 (at "D"), conductor 353, terminals 88 (at "6") and 87 (at "6"), contacts 351, terminals 87 (at "5") and 88 (at "5"), conductor 354, contacts of banks 113 (at "A") and 113 (at "D"), conductor 355 to potentiometer 112.

It will be understood that by introducing a resistance in the respective filament energizing circuit switch 102 (or 102a) will slow down the build-up of surges; in addition, this build-up may also be influenced by modifying the filter constants of the rectification network as described in connection with filter 59a.

The relay 90 is energized in series with the load circuit of a thyratron 356 which is triggered from a thyratron 357, the latter having its input circuit connected across a bleeder resistor 358 which terminates the network 56.

Thyratron 357 fires when a condenser 359 becomes sufficiently charged over a circuit leading from terminal 360, conductor 361, resistor 362, terminals 322 (at "1") and 323 (at "1"), conductor 363, control potentiometer 100, conductor 364, terminals 323 (at "2") and 322 (at "2"), conductor 365 to the plate of tube 357; a discharge of tube 357 will extinguish the tube 356 which, over conductor 366, had been ionized by the positive potential on condenser 359. The circuit for tube 356 may be traced from terminal 360, conductor 367, coils of relays 90, 90a, resistor 368, tube 356, conductor 369, terminals 87(at "8") and 88 (at "8"), conductor 370, control potentiometer 101 to ground. It will thus be understood that potentiometer 100, which controls the rate of charge of condenser 359, determines the frequency of operation of thyratron 357 and, thereby, of thyratron 356, thus controlling the number of interruptions or surges per minute; furthermore, potentiometer 101 fixes the cathode potential of tube 356, thereby determining the moment of energization of that tube and controlling the length of the conductive period thereof, which in turn determines the length of energization of relay 90.

The further thyratrons 371, 372 control the energization of relay 310 in similar manner as thyratrons 356, 357 control that of relay 90—90a. The energization of tube 372 is determined by a plate condenser 373, corresponding to condenser 359, and the connection between tubes 371 and 372 on the one hand and network 56 on the other hand is effected over a conductor 374 and two terminals 375, 376 which are insulated from each other except when switch 106 is in position II and switch 107 in position III or IV.

In the latter case, the connection between these terminals leads from terminal 376, terminals 322 (at "4") and 323 (at "4"), conductor 377, contact 201, associated contact in bank 107 (at "C") or 107 (at "D"), conductor 378, contact 213, associated contact in bank 106 (at "B"), conductor 379, terminals 323 (at "3") and 322 (at "3"), to terminal 375.

A connection 390 between the cathode of tube 356 and the control grid of tube 371 insures simultaneous firing of these tubes, thus, synchronizing the relays 90 and 310. It will be understood, however, that the circuits may be arranged so that tube 371 fires only upon every second, third, etc., ionization of tube 356, so that the operating rate of relay 90 will be a multiple of that of relay 310.

An oscilloscope 380 (Fig. 5) is connectable in the circuit of Figs. 3 and 4 by means of a socket 381 having its terminals #5 and #6 connected across the secondary of transformer 53 by means of conductors 382, 383. Conductors 384, 385, 386 and 387 connect terminals 381 (at "1"), 381 (at "2"), 381 (at "3") and 381 (at "4"), respectively, to the #8, #7, #6 and #5 terminals of plug 341, the corresponding terminals of plug 342 being connectable to test terminals 152 and to a suitable source of scanning potential, (not shown).

A D.-C. indicator lamp 388 corresponds to the pilot lamp 303 in the A.-C. circuit.

Referring now more particularly to Fig. 5, there is shown a movable cabinet 400 which houses in its interior the various circuit elements just described and which is provided with a control panel 401, this panel being more fully described in connection with Figs. 1 and 2.

The cabinet 400 has in its lower portion a door 402 which, when opened, gives access to the oscilloscope housing 403, this housing being a box-like insert held slidably in the cabinet by means of rails 404, 405 and cooperating guides such as 406. Housing 403 is also provided with a top panel 407 having mounted thereon the oscilloscope tube face 380 as well as the associated controls. The latter include intensity and focus controls 408, 409, respectively; knobs 410, 411 for varying the bias on the vertical and horizontal deflecting electrodes, respectively, whereby the vertical and horizontal position of the luminous trace may be varied; means for varying the scanning frequency, including a range selector 412 and a vernier frequency control 413; and vertical and horizontal gain controls 414, 415, respectively. There is further provided a three-position switch 416 operable to connect the oscilloscope 380 to the A.-C. circuit, to the D.-C. circuit or to both circuits simultaneously, the latter connection resulting in the superposition of one current, which modulates another current on the oscilloscope screen. It will be understood that, in certain instances, a simultaneous treatment of a patient with both types of current is desirable, in which case the last-mentioned position of the switch 416 enables the operator to ascertain exactly the wave form of the current employed.

It will thus be seen that the oscilloscope 380 will in all instances give a faithful and instantaneous indication of the various current modalities used in the treatment; accordingly, the operator will be able to adjust his controls until a desired amplitude and wave form is obtained, without having to depend upon hit-or-miss procedures or observation of physiological reactions or having to memorize the exact positions of a relatively large number of controls.

Some of the wave forms capable of being produced on the oscilloscope screen are illustrated in Fig. 6. Graph *a* of this figure shows a continuous alternating current of sinusoidal shape, graph *b* a similar current of square wave form. Graphs *c* and *d* represent surging and interrupted alternating current, respectively. Graph *e* shows pulsating direct current of predetermined amplitude, obtainable in the D.-C. circuit with half-wave rectification (switch 107 in position II, switch 109 in or near its lowermost position). Graph *f* represents surging direct current of the pulsating type; graph *g* illustrates an example of interrupted direct current. The current of graph *h* is the same as that of graph *e*, except that switch 107 stands in position IV, thus causing periodic reversals of polarity; similarly, graph *i* shows the alternating-polarity form of the current illustrated in graph *g*, while graph *j* is an example of a surging direct current (e. g. graph *f*) with alternating polarity.

The manner in which these various current modalities are obtained will be clear from the preceding description of Figs. 3 and 4 and need not be repeated.

Although the apparatus hereinabove described with respect to one of many possible adjustments of its switches is primarily contemplated for electro-therapeutic treatment plants, it is well apparent that the apparatus may be used for industrial purposes, in particular for electro-baths, as well.

Interrupted direct as well as alternating current may be used for shock treatments, for muscle exercises to break up lesions and to stimulate nerves and muscle tone (muscle strength). To determine the reaction of degeneration direct and alternating current may be applied successively to the same body part.

According to the invention, four electrodes may be used at the same location of treatment, one pair of electrodes being used for only one current type (for instance A. C.), and the other pair of electrodes is used for another current type (namely D. C.). Both current types may be modulated to surging and/or interrupted currents with the same speed and at the same time. For instance: surging alternating current may be employed with predetermined speed, whereas direct surging current is applied with the same speed but with a polarity change after each surge. The simultaneous application of such current modulations to a body has been found in practice to give beneficial results for the reason that the contraction produced by the alternating current becomes less noticeable to the patient and is felt with less discomfort when as a base current direct current is simultaneously applied.

The direct current is preferably used for medical galvanism, muscle and nerve testing, for iontophoresis and galvano-surgery.

The surging current is beneficial for muscle exercises and for muscle and nerve testing.

According to the invention, the current applied may be transformed from straight form to interrupted or surging forms or a ripple current may be otained which, besides chemical action produces slight stimulating vibrations in the tissues of the patient. The alternating current may further be changed to assume either a sine wave or square wave according to the action desired.

Although the invention has been described with respect to certain specific embodiments thereof, it is to be distinctly understood that various modifications and adaptations of the arrangements herein disclosed may be made, as may readily occur to persons skilled in the art without constituting a departure from the spirit and scope of the invention as defined in the objects and in the appended claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. In a treatment plant for therapeutic use on the human body, in combination, a transformer, an A. C. circuit connected to said transformer, means in said A. C. circuit for adjusting the A. C. in said A. C. circuit so as to change the wave form thereof, a rectifier network connected to said transformer, a D. C. circuit connected to said rectifier network, means in said D. C. circuit for adjusting the D. C. in said D. C. circuit so as to change the form thereof, an oscilloscope having a screen for displaying curves of a current fed to said oscilloscope, and a switch having a first position, a second position and a third position, said switch connecting said oscilloscope to said A. C. circuit in the first position of said switch, to said D. C. circuit in the second position of said switch, and simultaneously to said

A. C. circuit and said D. C. circuit in the third position of said switch, whereby said screen displays in the first position of said switch the A. C. in said A. C. circuit, in the second position of said switch the D. C. in said D. C. circuit, and in the third position of said switch a superposition of the A. C. in said A. C. circuit and the D. C. in said D. C. circuit.

2. A treatment plant according to claim 1, wherein said means for adjusting said A. C. includes means for interrupting said A. C. periodically.

3. A treatment plant according to claim 2, wherein said means for adjusting said A. C. includes means for imparting a surging wave form to said A. C.

4. A treatment plant according to claim 3, wherein said means for adjusting said D. C. includes means for interrupting said D. C. periodically in the same rhythm as that in which said A. C. is interrupted by said A. C. interrupting means.

5. A treatment plant according to claim 4, wherein said means for adjusting said D. C. includes means for imparting surges to said D. C. in the same rhythm as that of said surging wave form imparted to said A. C. by said A. C. adjusting means.

6. In an electro-therapeutic treatment plant: a plurality of sources of power, alternating current power source and direct current power source, respectively, each provided with a respective output circuit, current outlet means for connection with an applicator for use in therapeutic treatment, respective control means for changing the type of alternating current and of said direct current, and means common to said alternating current circuit and to said direct current circuit for modulating a predetermined type of current derived from at least one of said circuits, and further means common to said alternating current circuit and to said direct current circuit for adjusting other predetermined types of current in each of said circuits.

7. In a treatment plant according to claim 6, wherein said predetermined type of current is a surging current.

8. In a treatment plant according to claim 6, wherein said predetermined type of current is a pulsating current.

9. In a treatment plant according to claim 6, wherein said predetermined type of current is a surging alternating current in said alternating current circuit and a surging direct current in said direct current circuit.

10. In an electro-therapeutic treatment plant: an alternating current circuit including a power source therefor, a direct current circuit including a power source therefor, means for changing the alternating current in said alternating current circuit, means for changing the type of current in said direct current circuit, means common to said alternating current circuit and to said direct current circuit for modulating predetermined types of current in said alternating current circuit and in said direct current circuit, further means common to said alternating current circuit and direct current circuit for adjusting other predetermined types of current in said alternating current circuit and in said direct current circuit, and outlet means for connection with an applicator for therapeutic treatment whereby varying types of alternating current and of direct current may be applied to a human body to be treated.

11. An electro-therapeutic treatment plant comprising a plurality of circuit means, said circuit means including a circuit for direct current and a circuit for alternating current, first control means common to and connected with both said direct current and said alternating current circuits, whereby one predetermined type of alternating current and one predetermined type of direct current may be simultaneously operated, and second control means in said alternating current circuit for changing the frequency of said one type of said alternating current, and current outlet means for connection with applicator means for use in therapeutic treatments.

12. A treatment plant according to claim 11, wherein said predetermined type of alternating current and said predetermined type of direct current are surging currents whose surges per time unit are operable by said first control means to thereby change the speed of said surges with respect to the same value and simultaneously in both said direct current and said alternating current circuits.

13. A treatment plant comprising a plurality of circuit means, said circuit means including circuits of different types of currents, first control means for changing the output of said current circuits, and second control means for selecting predetermined forms of said current types, whereby said different current types may be identically modulated.

14. A treatment plant according to claim 13, wherein said circuits of different types of currents are constituted by a circuit for sinusoidal alternating current and a circuit for sinusoidal alternating current having different frequencies.

15. A treatment plant according to claim 13, wherein said circuits of different types of currents comprise a circuit for sinusoidal alternating current and a circuit for square alternating current both having substantially equal frequencies.

16. A treatment plant according to claim 13, including terminal means connectable with said circuits, and switch means actuatable for separating said terminal means of one type of said currents substantially instantaneously from the other type of said currents.

FRED S. LANDAUER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
556,617	Carter	Mar. 17, 1896
586,622	Porter	July 20, 1897
1,718,374	Oberst	June 25, 1929
1,980,911	Coupleux	Nov. 13, 1934
2,004,751	Fischer et al.	June 11, 1935
2,066,333	Caruthers	Jan. 5, 1937
2,226,459	Bingley	Dec. 24, 1940
2,252,613	Bingley	Aug. 12, 1941
2,295,535	Lindquist	Sept. 15, 1942
2,355,363	Christaldi	Aug. 8, 1944
2,424,972	Dubin	Aug. 5, 1947
2,456,970	MacDonald	Dec. 21, 1948
2,467,474	Hadfield	Apr. 19, 1949