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HIGH FREQUENCY APPARATUS FOR THERAPEUTIC AND SURGICAL USES

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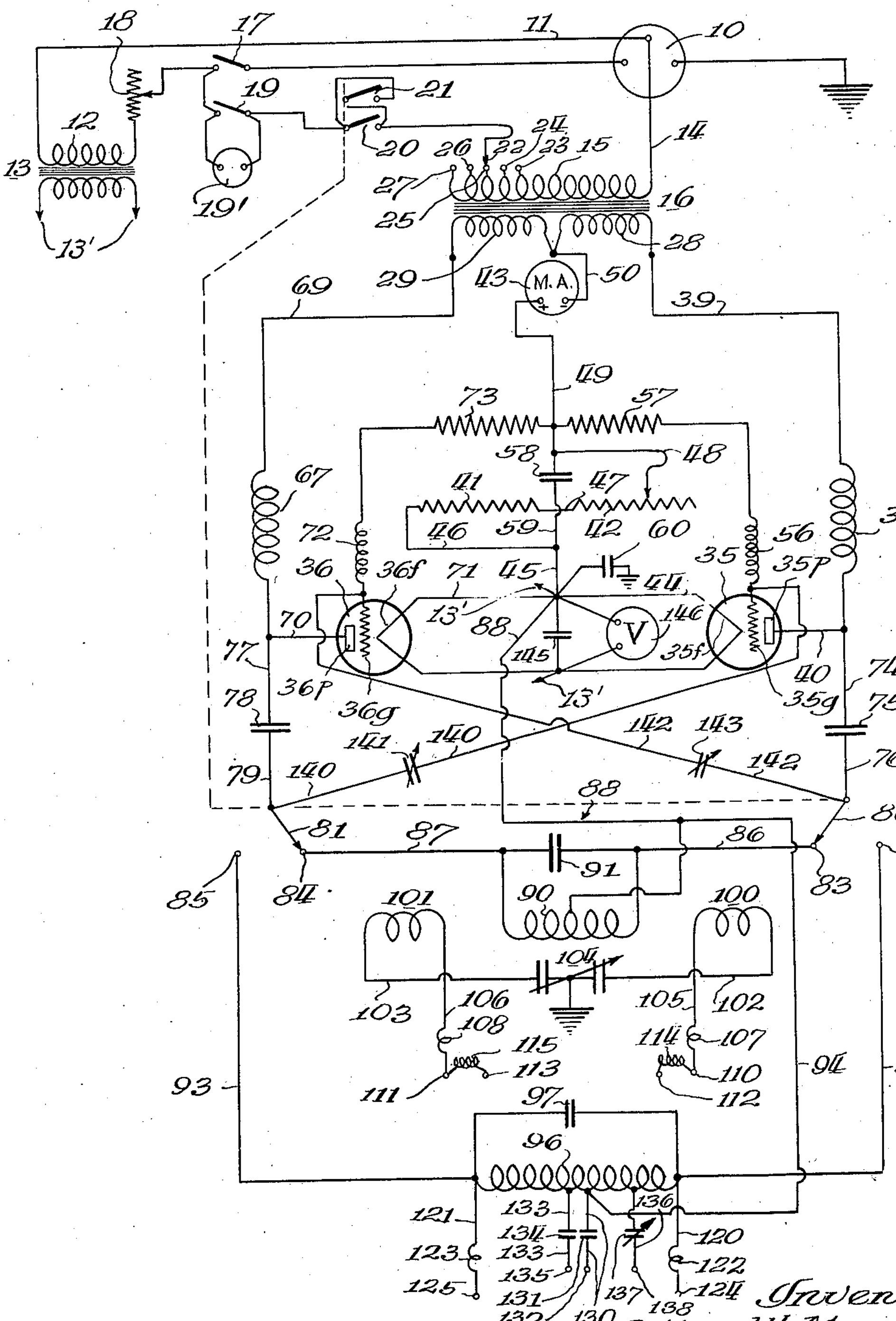

Inventor:
Rolland H. Maxson
By Williams, Bradbury, McCaleb & Hinkle
Attys.

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HIGH FREQUENCY APPARATUS FOR THERAPEUTIC AND SURGICAL USES

Rolland H. Maxson, Milton, Wis., assignor to The Burdick Corporation, Milton, Wis., a corporation of Delaware

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My invention relates to high frequency apparatus for therapeutic and surgical uses.

It has been generally recognized for some time that high frequency electrical currents in various wave length ranges seem to be especially adaptable for certain particular uses by the doctor and the surgeon. Thus, for example, currents of short wave lengths, of which about fifteen meters may be taken as typical, can be effectively applied by spaced electrodes which are insulated from the patient to provide, with the tissue, the effect of an electrical condenser. The current so applied, usually by means of a pair of spaced insulated electrodes in the form of flat "pads" or encircling "cuffs," produces heat which is more or less concentrated in the skin and subcutaneous tissue between the two electrodes and is relatively shallow of penetration. Currents of somewhat longer wave lengths, of which about twenty-five meters may be taken as typical, can be effectively applied (preferably by means of a flexible conducting insulated cable capable of being formed into flat ("pancake") or spiral coils of one or more turns) so as to create a magnetic field and thereby induce secondary (eddy) currents which tend to concentrate in the conductive tissue, such as muscle, blood vessels, nerves, and visceral organs. A suitable flexible cable may be provided by applying a tubular copper braid about a core of rope and then covering the braid with flexible rubber. The current so applied—by encircling a part of the patient's anatomy with one or more turns of the cable or by placing the "pancake" coils thereof flatwise against the patient—produces heat in the deeper tissues and is effective in creating so-called "artificial fever." Again, a current of still longer wave length—say, about seventy meters—is admirable for electro-surgical technique, such as cutting and coagulation, and for the production of heat caused by current flowing between electrodes—especially when applied internally—in direct conducting contact with the skin or mucous membrane.

For the production of currents of such wide range of wave lengths (frequency) as, for example, between fifteen and seventy meters, and to operate to best advantage in such a variety of applications as by electrostatic field, by magnetic field, and by direct contact conduction, a number of factors which are inconsistent with or opposed to each other must be taken into account. Thus, the electrostatic field (condenser) application is best served by a current of high voltage and relatively low amperage. And since the heat depends upon the strength of the electrostatic field, it follows that the circuit must have a high ratio of inductance to capacity in order that a high voltage may be delivered at the patient's electrodes. On the other hand, just the opposite characteristics are best for the magnetic field application. Because the magnetic field strength is a function of the cable ampere turns, it follows that for this application the amperage should be high and the voltage relatively low.

It will be obvious, therefore, that for these two applications (which, for convenience may be termed "short wave diathermy") entirely different inductance-capacity ratios are necessary in a circuit effectively to provide the requisite high frequency oscillating current. In other words, a circuit for delivering current at high voltage and low amperage must have a small capacity and large inductance, whereas a circuit for delivering a current of low voltage and high amperage must be characterized by a large capacity and a low inductance.

Furthermore, the longer wave length (lower frequency) current (say, seventy meters) which is best adapted for surgical, coagulatory and direct-contact-conduction ("long wave diathermy") applications cannot be effectively produced from circuits which are effective for producing either of the shorter wave (higher frequency) diathermy currents. The cutting current is very hard to control. When this application is attempted by current produced from short wave diathermy current circuits, severe flashing and arcing between the active electrode and the tissue takes place, and the power obtained is too limited for many operations where it is desirable to employ electro-surgical technique.

The problem which this invention solves is selectively to provide any one of three such widely different high frequency currents by means of a single unit (as contrasted to three separate units, each producing its own variety),—the current in each of the several ranges being as effective as when produced individually, and wherein none of the circuits is a compromise with a circuit for producing current in any other frequency range.

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Another object is to provide an apparatus which will selectively produce the current desired for any one of its three-purpose applications from a single source of alternating current of the usual frequency and voltage and will require but two thermionic tubes.

Another object is to provide an apparatus affording adequate protection for the patient against the inadvertent application of current of line (commercial source) frequency.

Another object is to provide an apparatus which is simple, reliable and effective for the intended purposes.

Other objects and advantages will hereinafter appear.

The accompanying drawing is a schematic diagram of my preferred circuit.

More specifically, the circuit arrangement illustrated and now to be described is particularly adapted to provide, from a single alternating current source of the customary frequency and voltage and with one pair of thermionic oscillator tubes, the following: (1) a fifteeen-meter condenser or "pad" current of 425 watts at the terminals of a patient's circuit, (2) a twenty-five meter cable current of 425 watts at the terminals for the cable, and (3) a seventy-meter current for electro-surgery coagulation and "long wave diathermy."

Referring to the drawing, the power line or source is connected through a plug receptacle **10**. One terminal of receptacle **10** is connected by a conductor **11** to one end of a primary **12** of a filament transformer **13**, used to heat the filaments of the thermionic tubes to be later described and to which it is connected by conductors **13'**, and by a conductor **14** to one end of the primary **15** of a tube-plate transformer **16**. The other terminal of the receptacle is connected through a main switch **17** and a rheostat **18** to the other side of the primary **12** of the filament transformer. This terminal of the line receptacle is also connected through a hand-actuated oscillator input switch **19**, a pair of snap switches **20** and **21**, an adjustable transformer contact **22** and any selected one of a plurality of taps **23** to **27** to the opposite side of the primary **15** of the plate transformer **16**. If desired, a foot-operated switch, serving the same purpose as hand switch **19**, may be connected in parallel with the hand switch through a suitable plug receptacle **19'**. The taps **23** to **27** are to permit adjustment of the primary winding of the plate transformer for variations of line voltage of 105, 110, 115, 120 and 125 volts, respectively (which will afford proper accommodation for such voltage variations as are found in ordinary commercial power lines), and the ratio of transformation is such that the secondary delivers 5,000 volts,—2,500 volts for each half section **28** and **29** of the secondary. The ratio of the primary and secondary windings of filament transformer **13** is such that the secondary will deliver current at a voltage ratio of ten-to-one to that impressed on the primary. Rheostat **18** is variable (say, from 0 to 35 ohms) and should be adjusted to keep the voltage impressed upon the tube filaments between 10 and 10.5 volts,—the voltage range within which it has been found that so-called "thoriated" tubes (the kind I prefer to use) operate to best advantage.

The two halves **28** and **29** of plate transformer **16** are in two circuits (one for each half wave of the source current) which supply low frequency power current and include the electrodes of two thermionic tubes **35** and **36**, respectively. The low frequency power current circuit for tube **35** includes a radio frequency choke coil **37** which is connected between the outside terminal of secondary **28** and the plate **35p** of tube **35** by conductors **39** and **40** and which serves to exclude radio frequency current from the plate transformer winding **28**. This circuit also includes the filament **35f** of tube **35**,—which filament is connected across the secondary winding of filament transformer **13** through conductors **13'**, as indicated. It also contains two cathode bias resistances **41** and **42** and preferably an indicating current-meter **43**. Connections are made through the conductors **44**, **45**, **46**, **47**, **48**, **49** and **50**, back to the mid point between secondary sections **28** and **29**. Resistance **41** may be of 250 ohm, 100 watt capacity while variable resistance **42** is preferably in the form of a 0-4000 ohm rheostat. Meter **43** may be a 0-400 D. C. milliammeter.

The grid **35g** of tube **35** is connected to conductor **49** through a choke coil **56** and a grid leak resistance **57**. From conductor **49** the grid leak to ground includes the condenser **58**, conductors **59** and **45** and condenser **60**. Good results can be obtained by making resistance **57** of 10,000 ohm, 100 watt capacity. Choke coil **56** serves to keep the radio frequency grid voltage in proper phase relation to the plate voltage and to balance the grid to ground. Resistance **57** is a grid leak to furnish grid bias.

The low frequency power circuit for the other half wave includes the choke coil **67**, the plate **36p** of tube **36**, and the conductors **69** and **70** by which the choke coil is connected to the outside terminal of transformer secondary **29** and to plate **36p**, respectively. This circuit also includes the filament **36f** of tube **36**, (which likewise is connected across the secondary winding of filament transformer **13** through conductors **13'**, as indicated), the two cathode biasing resistances **41** and **42**, meter **43** and the intermediate conductors **71**, **45**, **46**, **47**, **48**, **49** and **50**. The grid **36g** of tube **36** is connected to ground through a choke coil **72**, a grid leak resistance **73**, and through condensers **58** and **60**, as in the case of the grid of tube **35**.

The high frequency (generally termed "radio frequency") output side of tubes **35** and **36** may be selectively connected to one of a plurality of tank circuits with which tank circuits the patient's terminals for the different frequency outputs are associated. This connection is made through conductor **74**, condenser **75** and conductor **76** for one oscillator tube, and through conductor **77**, condenser **78** and conductor **79** for the other oscillator tube. Condensers **75** and **78** are high voltage, having a rating of about .001 microfarad and 10,000 volts, and serve to block 60 cycle (i. e., low frequency) currents from the tank circuits, but to permit radio frequency current to flow. These condensers and the choke coils **37** and **67** cause the tubes to be self-rectifying and to operate in what is generally termed "full wave" so that both alternating current half cycles or complete waves are taken from the plate transformer. This results in a high power factor on the source line. The tubes operate in so-called "push-pull" into the radio frequency oscillator.

Selection of tank circuits is effected by a double-bladed radio frequency switch, the movable contacts **80** and **81** of which are simultaneously operated. Blade **80**, which is permanently connected to conductor **76**, may be moved to engage either of two fixed contacts **82** and **83**, while blade **81**, which is permanently connected to conductor **79**, is moved at the same time to engage either of two fixed contacts **84** and **85**, respectively. When this radio frequency switch is in the position shown with blades 80 and 81 engaging fixed contacts 83 and 84, respectively, the oscillator tubes are, by conductors 86, 87 and 88, connected to a tank circuit which includes the fifteen-meter tank inductance 90 and the fifteen-meter tank capacitance condenser 91. When the blades of the radio frequency switch are transferred so that they engage the contacts 82 and 85, respectively, the oscillator tubes are associated, by conductors 92, 93, 94 and 88, with a tank circuit which includes a seventy-meter tank inductance 96 and a seventy-meter tank capacitance condenser 97.

It is desirable to insure that the flow of plate current to tubes 35 and 36 is interrupted before the blades 80 and 81 break circuit with their fixed contacts and that the plate current does not again begin to flow until the blades have engaged one or the other of their two fixed contacts, in order that there may be no radio frequency current upon the switches when they are opened and closed and while they are open. This result may be accomplished by mounting the snap switches 20 and 21 upon a shaft common to blades 80 and 81 and making the blades 80 and 81 fan or segment-shaped so that they remain in engagement and out of engagement with their fixed contacts for intervals long enough to enable the snap switches to operate to closed position or to open position (to complete or break the plate primary winding circuit) before the blades 80 and 81 engage or leave their fixed contacts. The dotted line in the circuit diagram indicates that blades 80 and 81 and snap switches 20 and 21 are operated together by a single handle.

In order that the thermionic tubes may function to cause the production of the necessary high frequency oscillations from the 60-cycle supply, a "feed back" radio frequency excitation for the grids is provided from the one or the other previously described tank circuits, depending upon which one of the tank circuits is connected to the output side of the oscillator tubes by switches 80—82—83 and 81—84—85. To provide this feed back excitation, the grid 35*g* of tube 35 is connected to the blade 81 of the radio frequency switch through conductor 140 and a variable condenser 141; and the grid 36*g* of tube 36 is connected to the blade 80 of the radio frequency switch through a conductor 142 and a variable condenser 143. As a result of these connections a feed back to the grids is provided by the tank circuit including inductance 90 and capacitance 91 or including inductance 96 and capacitance 97, depending upon whether the blades of the radio frequency switch are in engagement with contacts 83—84 or contacts 82—85. Condensers 141 and 143 are of about 35 micro-microfarads capacity and are made adjustable so that excitation in proper phase and amount may be impressed upon the tube grids. After this initial adjustment has been made, however, no further adjustment will ordinarily be necessary.

The low voltage condenser 145 is bridged across the filaments 35*f* and 36*f*. This condenser, together with condensers 58 and 60, should be of about .002 microfarad capacity each. They serve to maintain the radio frequency balanced to ground at the electrical center of the network.

The fifteen-meter tank inductance 90 acts upon a pair of secondary windings 100 and 101 which have their outer terminals connected by conductors 102 and 103, respectively, to the opposite sections of a split-stator type of condenser 104,—each section of condenser 104 having a capacity of about 100 micro-microfarads and with the rotor thereof grounded. The purpose of this adjustable condenser is to tune the fifteen-meter output circuit to resonance with the corresponding tank circuit.

The other terminals of these secondaries 101 and 100 are connected through conductors 105 and 106 and impedance matching inductances 107 and 108, respectively, to a pair of fifteen-meter patient's terminals 110 and 111. If desired, two additional fifteen-meter or "pad" or "cuff" patient's terminals 112 and 113 may be connected to the output circuit through inductances 114 and 115, respectively. These inductances 107, 108, 114 and 115 are for the purpose of adding inductance to the fifteen-meter output circuit to obtain the proper relation between inductance and capacity in that circuit and thereby obtain the proper resonance and impedance match conditions. All of them should be outside of the magnetic fields of inductance windings 90, 100 and 101 so as not to pick up energy therefrom. The reason for the extra set of patient's terminals 112 and 113 and inductances 114 and 115 is to afford a greater voltage range for the fifteen-meter output circuit. In other words, they permit the patient's circuit, with smaller "pads" and "cuffs" or a greater spacing of condenser electrodes, to be tuned to resonance.

The ends of inductance 96 of the seventy-meter tank circuit are connected by conductors 120 and 121 and inductances 122 and 123, respectively, to the patient's "cable" terminals 124 and 125. When an inductance cable of about twelve feet (which length I have found is practical for general purposes) is connected to terminals 124 and 125, the cable is shunted around inductance 96 and, inasmuch as the inductance of the cable is low compared to that of inductance 96, practically all of the tank current flows through the cable. Thus, when the radio frequency switches are moved to the position where movable contacts 80 and 81 engage fixed contacts 83 and 85, respectively, and the treatment cable terminals are connected to the patient's terminals 124 and 125, the cable virtually becomes the tank inductance under such conditions and the resonant wave length becomes about twenty-five meters. The wave length may vary a little from the average of twenty-five meters, depending upon variations in cable inductance due to differences in the number of cable turns deemed most desirable for particular treatment conditions, but I have found that normally such variations do not exceed the range of 22 to 28 meters. The inductances 122 and 123 tend to minimize over-coupling of the cable resistance to the oscillator when the cable is uncoiled or straightened out and, consequently, its inductance is relatively low.

From the inductance 96 taps may be taken to provide seventy-meter current to patient's terminals for coagulation, for cutting (electro-surgery) and for "long wave" diathermy. Thus, from a central tap the conductor 130 may lead through a condenser 131 to an inactive or return terminal 132 to which may be connected the inactive electrode of the patient's circuits for the several seventy-meter modalities. From another tap a conductor 133 may lead through a condenser 134 to a "coagulation" electrode 135, to which may be connected the active electrode for coagulation technique. Condensers 131 and 134 may be of low voltage rating of about .002 microfarad capacity. They provide blocking capacity which allows radio frequency current to pass, but further insulate the patient against the possibility of receiving current of the low frequency (60 cycle) of the source. From another tap a conductor 136 may lead through a variable condenser 137 to an "electro-surgery" or cutting circuit patient's terminal 138. This condenser, which may be of 150 micro-microfarads capacity, acts as a series impedance to regulate the strength of the electro-surgery (or, as it is often termed, the "dissection") current. The electrodes for "low frequency diathermy" applications may be connected to the inactive terminal 132 and the coagulation terminal 135.

For convenience a volt meter 146 is also bridged across the filament circuits. A 0-to-13 volt A. C. instrument may be used. It may have its indicating dial calibrated to show to which tap of transformer primary 15 the adjustable contact 22 should be connected. Thus, when the resistance 18 is adjusted to its all out or zero position, the meter 146 indicates a voltage directly proportional to the source or line voltage. The meter 43 serves as a resonance indicator for the fifteen-meter ("pad") circuit and since the plate current passing through it is proportional to the power output, it also serves as a meter or indicator of the power output.

The total plate current which flows through tubes 35 and 36, through resistance 41 and rheostat 42 causes a voltage drop in proportion to the plate current. When either tank circuit is loaded, the grid bias offered by resistances 57 and 73 falls off; but the plate current increases, causing a greater voltage drop over resistances 41 and 42, which adds more grid bias, tending to increase plate efficiency and minimize danger of overload. In addition, rheostat 42 may function to control the oscillator output by controlling the input. That is, as the effective (adjusted) resistance of rheostat 42 is increased, the radio frequency plate current from the tubes flows into the connected tank circuit over a shorter period of the radio frequency cycle, causing less power to be delivered to the tank circuit.

The electronic tubes, transformers, inductances, condensers, resistances and switch contacts may be mounted in a suitable cabinet which will also mount the meters. The operating handles for the switches and for the variable resistances and condensers should preferably project through the walls of the cabinet so as to be operable from the outside, and the various "patient terminals," preferably of the plug receptacle type, should be readily accessible from the outside so that the conductors for the various "patient circuits" may be quickly and easily connected and disconnected.

In operation the apparatus is connected to the power supply line through plug receptacle 10. With rheostat 18 adjusted to its "all out" or zero position and with main switch 17 closed, and oscillator switch 19 open or in "off" position, the line voltage can be determined (or if so calibrated, the proper tap of transformer 16 can be directly determined) by meter 146. The movable contact 22 of transformer 16 is moved to the proper tap 23 to 27 to give the proper secondary voltage for the particular line voltage available. Ordinarily this adjustment needs to be made only once for a given power circuit.

Rheostat 18 is now adjusted so that the filaments of tubes 35 and 36 have from 10 to $10\frac{5}{10}$ volts impressed upon them, as indicated by meter 146.

If electro-static (or so called "pad" or "cuff") treatment is to be given, the radio frequency switch is moved so that its movable contacts 80 and 81 engage fixed contacts 83 and 84 respectively. With the radio frequency switch in this position and with switches 17 and 19 closed, the oscillator is actively associated with the terminals or plug receptacles 110, 111, 112 and 113, and the previously described feed-back circuits are connected to the 15 meter tank circuit. Whether the patient electrode ("pad" or "cuff") circuits should be connected to terminals 110 and 111 or to terminals 112 and 113 depends, as previously explained, upon the desired size and spacing of the electrodes used in the treatment. The power supplied can be controlled by rheostat 42 and a condition of resonance can be secured by adjusting condenser 104 until ammeter 43 shows maximum reading for any given position of rheostat 42.

If either the electromagnetic field (cable) or any of the 70 meter modalities are to be employed, the radio frequency switch is moved to its other position with contacts 80 and 81 engaging contacts 82 and 85 respectively.

In this condition the oscillator is connected to the 70 meter tank circuit (inductance 96 and capacitance 97) or to a 25 meter tank circuit (the cable and capacitance 97) depending upon whether the cable is not or is plugged into terminals 124 and 125. In either event, the grid exciting feed-back circuits are associated with the corresponding tank circuit.

The current and consequently the power delivered to the cable or to the patient's terminals tapped into inductance 96 (if the cable is not connected to its patient's terminals) may be varied by adjusting rheostat 42. If the surgery or "dissection" electrode 137 is to be employed, the character and amount of current delivered thereto can be controlled by rheostat 42 and variable condenser 137.

Having thus illustrated and explained the nature and an embodiment of my invention, what I claim and desire to secure by United States Letters Patent is as follows:

1. An electro-therapeutic and surgical apparatus comprising a pair of oscillator tube circuits for push-pull association with and operation from a source of alternating current, each oscillator tube circuit including a thermionic tube having filament, plate and grid; a plurality of tank circuits of different electrical characteristics; a pair of switches for selectively connecting both oscillator tube circuits to either tank circuit; a pair of feed-back circuits, one for each oscillator tube circuit and each by the operation of one of the switches connecting the grid of one of the tubes to the tank circuit to which the oscillator tube circuits are connected, and a set of patient's terminals associated with each tank circuit.

2. An electro-surgical and therapeutic apparatus comprising a pair of oscillator tube circuits for connection to and operation from a source of alternating current, each oscillator tube circuit containing a thermionic tube having a filament, plate and grid; a plurality of tank circuits having different electrical characteristics so as to be resonant at different frequencies; a radio frequency switch for selectively associating either of the two tank circuits with the oscillator tube circuits; a feed-back circuit for the grid of each

tube, said radio frequency switch also serving to associate the feed-back circuits with whichever tank circuit is associated with the oscillator; a switch which is operated with the radio frequency switch to open the plate input circuits of the tubes previous to the opening of the connections between a tank circuit and the plate output circuits; and terminals for patients' circuits associated with each tank circuit.

3. An electro-therapeutic and surgical apparatus comprising a pair of thermionic tubes, each having a filament, plate and grid; a low frequency power current circuit for each tube, each power circuit delivering to one of the tubes alternate half cycles of current induced from an alternating current source; a plurality of tank circuits having different electrical characteristics so as to be resonant to high frequency currents of different wave lengths; a pair of switches, each having a movable contact permanently connected to the plate of one of the tubes and fixed contacts connected to the tank circuits so that transferring the movable contacts of the switches from one set to the other of their fixed contacts changes the tank circuit connected to the tubes; a feed-back circuit for the grid of each tube connected to the movable contact of the associated switch so that the tube grids are under the influence of whichever tank circuit is connected to the tubes; and patients' circuit terminals associated with each tank circuit.

4. An electro-therapeutic apparatus comprising a plurality of tank circuits which are resonant to high frequency currents of different frequencies and with the aid of which currents of different frequencies for various therapeutic uses may be obtained; a pair of thermionic tubes, each having a filament, plate and grid; means for simultaneously and selectively associating the high frequency side of both tubes with any one of the tank circuits, a pair of low frequency power circuits for associating the low frequency side of both tubes with a source of alternating current; and a pair of feed-back circuits, one for the grid of each tube, said circuits being connected by the aforesaid means to whichever tank circuit is associated with the tubes.

5. An electro-therapeutic apparatus comprising a pair of thermionic tubes, each having a filament, plate and grid; a pair of low frequency power input circuits for inductively associating the low frequency side of the tubes with a low frequency source of alternating current; a plurality of tank circuits resonant to high frequency currents of different frequencies and with the aid of which currents of various frequencies for various therapeutic uses may be obtained, one of said tank circuits having a high ratio of inductance to capacity and the other a low ratio of inductance to capacity; a pair of feedback circuits, one for the grid of each tube; means for simultaneously and selectively associating the high frequency sides of the tubes with any one of the tank circuits, said means at the same time connecting the feedback circuits to the selected tank circuit; and patients' circuit terminals associated with each of the tank circuits.

6. An electro-therapeutic apparatus comprising a pair of electronic tubes, each having a filament, plate and grid; a low frequency power input circuit for each tube to associate the same with a low frequency power supply line; a high frequency circuit including the filaments and plates of the tubes and any one of a plurality of tank circuits, one of the tank circuits including an inductive patients' cable, a feed-back circuit for providing high frequency excitation for the grid of each tube; and switches for selectively including any one of the tank circuits in the high frequency circuit and at the same time connecting the grid feed-back circuits to the selected tank circuit.

7. An electro-therapeutic apparatus comprising a pair of electronic tubes, each having a filament, plate and grid; a low frequency power input circuit connected to the filament and plate of each tube for each tube to supply the tubes with alternate half waves induced from a low frequency power supply line; a plurality of tank circuits resonant to high frequency currents of different frequencies and with the aid of which currents of various frequencies for various therapeutic uses may be obtained, one of said tank circuits having a high ratio of inductance to capacity and the other a low ratio of inductance to capacity; a pair of simultaneously actuated radio frequency switches for selectively completing any one of several high frequency output circuits by associating the filaments and plates of the tubes with the different tank circuits; a feed-back circuit for the grid of each tube connecting the grid to a switch, whereby said switches associate the grids with whichever tank circuit is associated with the filaments and plates thereof; and patients' circuit terminals associated with each tank circuit.

8. An electro-therapeutic and surgical apparatus comprising an oscillator tube circuit for association with and to be operated from an alternating current source, said circuit including a thermionic tube including a control electrode, a plurality of tank circuits having different electrical characteristics, a switch for selectively connecting said tank circuits to said oscillator tube circuit, and a feed back circuit adapted to be connected between the switch and the control electrode regardless of which tank circuit is connected to the oscillator circuit, one of said tank circuits including a condenser and a relatively high inductance and another of said tank circuits including a set of patients' cables having a relatively low inductance adapted to be connected across said condenser and said relatively high inductance.

9. An electro-therapeutic and surgical apparatus comprising a pair of thermionic tubes, each having a filament, plate and grid, a low frequency power input circuit for each tube including a connection from the power source to the plate and a connection from the power source to the filament, radio frequency chokes inserted in each of the plate connections, a plurality of tank circuits resonant to high frequency currents of different frequencies and with the aid of which currents of various frequencies for various therapeutic uses may be obtained, one of said tank circuits having a high ratio of inductance to capacity and the other a low ratio of inductance to capacity, a pair of switches, each having a movable blade connected to the plate of one of the tubes, said connections each including a condenser blocking the flow of low frequency current to the switch blade, a feed back circuit including variable condensers from each switch blade to the grid of the tube to which the other blade is connected, fixed contacts adapted to be engaged by said blades and connected to said tank circuits, and patients' circuit terminals associated with each tank circuit.

10. An electro-therapeutic and surgical appa-

ratus comprising a pair of thermionic tubes, each having a filament, plate and grid, a low frequency power input circuit for each tube including a connection from the power source to the plate, a pair of switches, each having a movable blade and simultaneously operable between two positions, each of said blades being connected to the plate of one of said tubes through a condenser blocking the flow of low frequency current to the blade, a feed back circuit from each switch blade to the grid of the tube to which the other blade is connected, a first tank circuit resonant at a wave length of about 15 meters adapted to be connected to said switches when the latter are in one position, a second tank circuit including a condenser and a relatively high inductance resonant at a wave length of about 70 meters adapted to be connected to said switches when the latter are in their other position, and a pair of terminals connected to said last mentioned inductance adapted to receive a low inductance patients' cable thereby to transform said second tank circuit to one resonant at a wave length of about 25 meters.

11. An electro-therapeutic and surgical apparatus comprising an oscillator tube circuit for association with and to be operated from a low frequency alternating current source, a plurality of tank circuits having different electrical characteristics, means including a switch for selectively connecting said tank circuits to said oscillator tube circuit, and switch means operable simultaneously with said last-mentioned switch to disconnect said tube circuit from said current source previous to the disconnection of a tank circuit from said oscillator tube circuit.

ROLLAND H. MAXSON.