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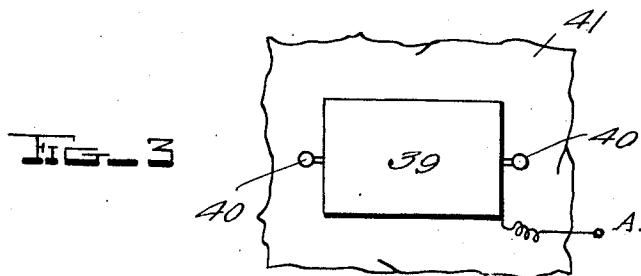
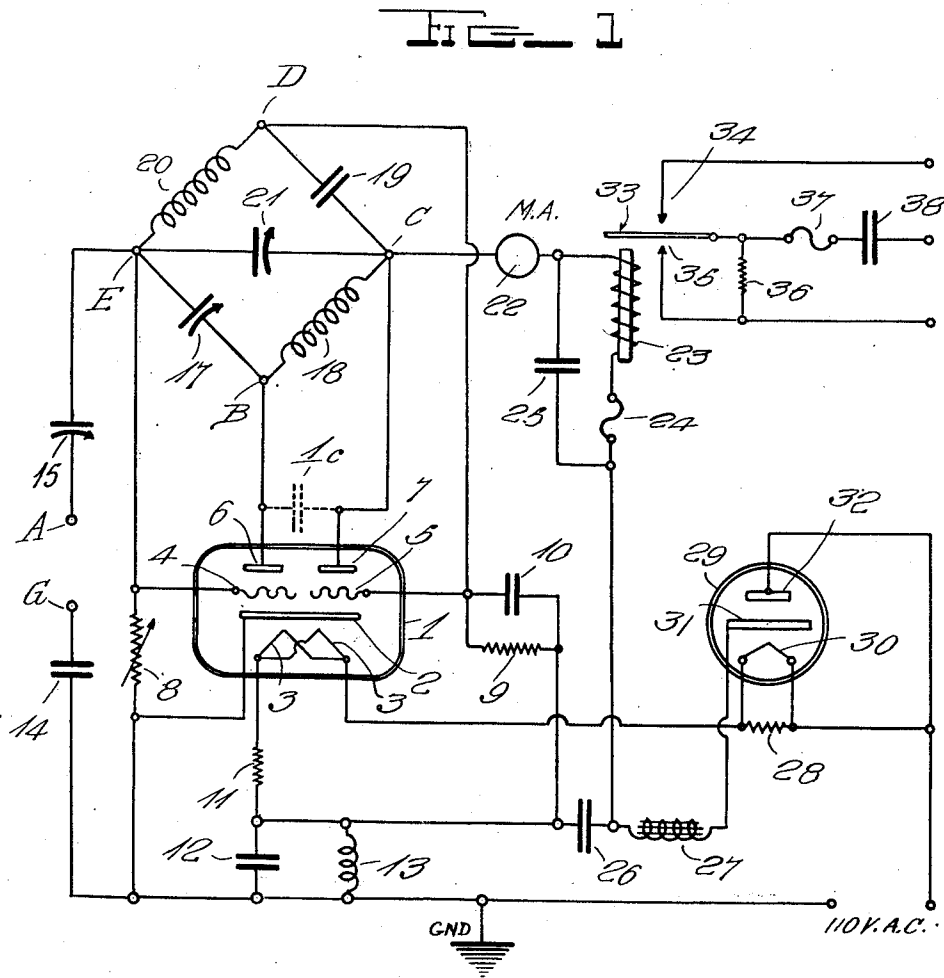
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2,041,114

ELECTRICAL DISCHARGE TUBE CIRCUITS

Filed Nov. 14, 1934

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

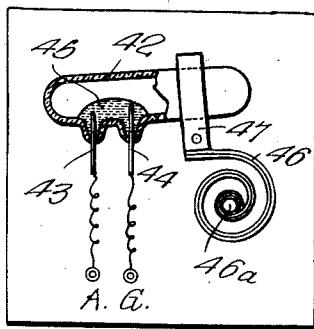
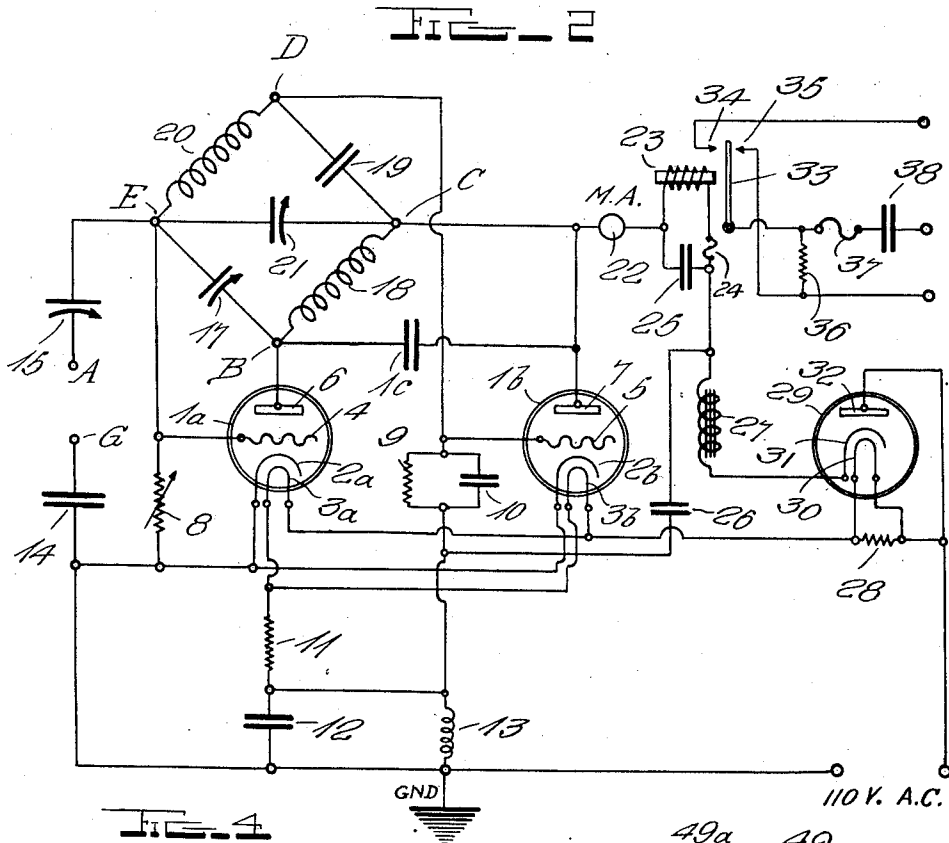
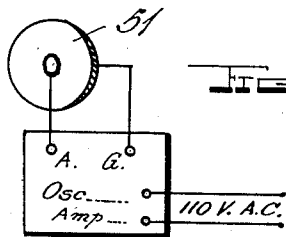
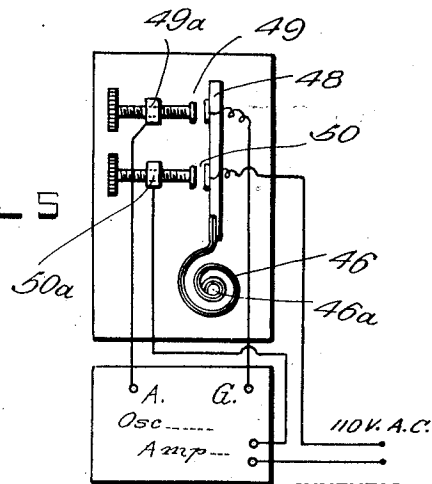


FIG. 5



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UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE TUBE CIRCUITS

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12 Claims. (Cl. 250—36)

This invention relates to electrical apparatus generally. More particularly, this invention relates to electrical discharge tube circuit arrangements particularly adapted for use as relays and controls.

An object of this invention is to provide a compact, sensitive and efficient electron discharge device oscillation generator adapted to be readily adjusted to maximum sensitivity and stability for the production of oscillations in accordance with a predetermined condition.

Another object of this invention is to provide a compact, sensitive and efficient electron discharge device or thermionic tube circuit arrangement adapted to operate as a relay controllable by a predetermined unbalancing of the circuit thereof to generate oscillations for operating a relay circuit.

Still another object of this invention is to provide a balanced circuit arrangement employing a dual type electron discharge device or thermionic tube for the purpose of generating and amplifying electrical oscillations during the predetermined unbalancing of the balanced circuit.

A further object of this invention is to provide a balanced bridge circuit connected between a pair of electron discharge devices or thermionic tubes one of which is adjusted to generate oscillations and the other of which is adjusted to amplify the oscillations.

In accordance with this invention I provide a sensitive and reliable circuit controlling arrangement which may be employed in numerous ways to control alarms, detecting circuits, mechanical production apparatus and conveyors and similar arrangements.

The apparatus of my invention consists of a sensitive balanced oscillation generating circuit adapted to produce oscillations upon the setting up of the predetermined electrical conditions. Oscillations of any predetermined frequency may be generated by the generator once the predetermined electrical conditions are set up. These oscillations are impressed upon the circuit of an amplifying device, preferably an electron discharge device, and the amplitude thereof is increased and if necessary rectified to operate a suitable electromagnet relay. A source of direct current supply for energizing the anode circuits of the oscillation generator and amplifier is incorporated therewith whereby the whole unit may be conveniently portable and set up for immediate use.

Further details of the circuit arrangement and details of my invention will be apparent from

the following drawings in which Figures 1 and 2 illustrate the circuit arrangements of my invention and Figures 3, 4, 5 and 6 illustrate forms of control adapted for use with the circuit.

Referring to the drawings in detail reference numeral 1 designates an electron discharge device of the dual type employing a cathode 2, cathode heating filament 3, grid electrodes 4 and 5 and anodes 6 and 7.

A variable grid biasing resistor 8 is connected to the grid 4 and the cathode 2 and also to the condensers 12 and 14. A choke coil 13 is connected across the condenser 12 and to the voltage reducing resistor 11 which is connected in series with the filaments 3 and 30 to enable these filaments to be heated from a relatively high voltage supply, such as, a 110 volt lighting circuit.

A resistor 9 and condenser 10 comprising a parallel circuit, are connected between the grid 5 and the filament circuit of this tube 1, as illustrated in Fig. 1. The anodes 6 and 7 of the tube 1 are connected across one inductance leg 18 of the inductance and capacity bridge circuit, which includes the capacity 17, inductance 18, capacity 19 and inductance 20 connected into a ring, to form the legs of the bridge circuit, such as, a Wheatstone bridge, and capacity 21 connected across two legs of the bridge.

The inductances 18 and 20 and capacities 17 and 19 are connected together into a ring designated by the letters B, C, D and E, as illustrated. The condenser 19 is connected to the points C and D of said ring, forming terminals of the inductances 18 and 20, respectively, and the condenser 17 is connected to the points B and E of said ring, forming the other terminals of the inductances 18 and 20, respectively. The condenser 21 is connected across the points C and E of said ring. The anodes 6 and 7 of the tube 1 are connected to the points B and C, respectively and the grid electrodes 4 and 5 are connected to the points E and D, respectively. Stabilizing condenser 21 is connected to the points E and C.

The condensers 15 and 14 are connected to the bridge circuit and the cathode 2 of the tube 1, respectively and to the terminals A and G, which are the input control terminals, as will be hereinafter more fully explained.

A small current meter 22 preferably a milliammeter is connected to the bridge circuit at a point where the capacities 19 and 21 and the inductance 18 are connected together. This meter is connected to the electrical winding of the relay 23 which is connected to the fuse 24 and the filter circuit of the power supply. This filter includes

the condenser 26 and the choke coil 27. Tube 29, having a filament 30, cathode 31 and plate 32, is used for rectifying the 110 volt alternating current supply. Where a direct current supply is available the rectifier tube 29 and filter may be dispensed with, if desired. This tube may, of course, be of any of the conventional designs, including the mercury vapor, gas filled or vacuum type of rectifiers. Contact types of rectifiers employing dissimilar metal surfaces having substantially unilateral electrical conducting properties may also be employed in place of the tube 29.

A resistor 28 is shunted across the filament 30 for the purpose of by-passing some of the heating current required by the filaments 3 of tube 1, where these latter filaments require a greater heating current than the filament 30. It is, of course, understood that a resistor may be shunted across the filament 3 in cases where the rectifier tube filament requires a greater heating current. In cases where dissimilar metal or chemical contact type rectifiers are used in place of the tube 29, the size of the resistor 28 would be reduced to compensate for the resistance of the filament 30 and, of course, the unit 28 could then be made a part of the resistor 11.

The relay 23 controls the armature 33 thereof to close the circuits of the contact 34 or contact 35. A suitable fuse 37 is included in the circuit controlled by the relay. A condenser 38 and resistance 36 are connected to the external electrical circuit controlled by the relay, where desired and it is, of course obvious that the arrangement of these units in the electrical circuit is governed to a large extent by the type of circuit.

The characteristics and values of the circuit components connected to the electrodes of the tube 1 are chosen and adjusted to permit one section of this dual tube to generate electrical oscillations and the other section to amplify or increase the amplitude of these oscillations.

The values of the various circuit components found to give satisfactory results with the dual type tube are as follows: Condensers 10, 12, 14, 15, 17, 19, 21, 25, 26 and 38 are preferably, 0.004 to 0.006 microfarad, 0.1 to 0.3 microfarad, 0.1 to 1 microfarad, minimum one micro-microfarad, 1 to 80 micro-microfarads, 0.005 microfarad, 1 to 75 micro-microfarads, 0.25 to 2 microfarads, 4 to 8 microfarads and 1 to 4 microfarads, respectively.

The resistors 8 and 9 are preferably variable between wide limits and resistor 8 may be varied between very low values to several million ohms. Resistor 9 may be anywhere from one to five megohms. Resistors 11 and 28 are 165 and 25 ohms, respectively. Choke coil 13 is 20 microhenries inductance and 50 to 100 ohms direct current resistance. The choke 27 is a conventional filter choke such as is used in power supplies and is about 15 henries inductance.

In the circuit illustrated in Figure 1 the anode 6 co-operates with the grid 4 and the cathode 2 in the generation of oscillations whereas the section of the tube including anode 7, grid 5 and cathode 2 function, together with the interconnecting components as an amplifier.

For the purpose of controlling the generation of oscillations by the first or oscillator section of the tube 1, different arrangements illustrated in Figs. 3, 4, 5 and 6, may be used.

A conducting plate 39 is connected to the terminal A, as illustrated in Fig. 3. This conducting plate may be held upon a convenient surface, such as, a show window glass 41 by means of rubber vacuum cups 40 or similar supports. The plate 39,

in this arrangement functions as one plate of a condenser, the other plate, co-operating with the circuit of the terminal G may be connected to this latter terminal and positioned at a short distance from the plate 39 or the ground GND connected to the cathode circuit of tube 1, as shown in Fig. 1, may be used without an additional plate connected to the terminal G.

The purpose of the plates connected to the terminals A and G and the ground connection is to permit the control of the operation of the oscillation generator by the variation of the electrical capacity formed by these conducting plates or by the capacity formed by the plate connected to terminal A and the ground. This variation in capacity may be obtained by the presence or absence of a human being adjacent to the plate or plates or by the waving of the operator's hand adjacent thereto.

Other forms of circuit control adapted to be used with the electron discharge device circuit herein described, are illustrated in Figs. 4, 5 and 6. A mercury type switch 42, shown in Fig. 4, having electrodes 43 and 44, connected to the terminals A and G, respectively, is suitable for controlling the circuit between the terminals A and G, and when attached to a bi-metallic strip 46 by means of a suitable clamp 47, this switch may be employed to control the operation of the oscillation generator at a predetermined temperature. The bi-metal strip 46 is preferably wound into a spiral with the inner end attached, by a suitable member 45a to a panel or wall. The outer end of the spiral bi-metal strip is attached to the switch clamp 47, of suitable material.

Fig. 5 illustrates a modified form of control employing a bi-metallic strip 45 or similar temperature responsive expansible member. A contact supporting member 48 is attached to the free end of the spiral 46. One of the contacts 49 is supported by the member 48 and the other is adjustably supported by a suitable screw and bracket 49a. Likewise, the contacts 50 are supported, one by the member 48 and the other by the screw and bracket 50a, which is adjustable. The contacts 49 are connected to the terminals A and G of the electron discharge device apparatus to control the generation of oscillations and if desired the auxiliary contacts 50 may be used to control the energization of the electron discharge device apparatus itself, from the 110 volt circuit. In this way the apparatus need not be energized from the 110 volt circuit except during the intervals determined by temperature.

As illustrated in Fig. 6 a photo-electric cell 51 or other type of light sensitive device may be used to control the circuit of the oscillation generating apparatus.

The dual electron discharge device 1 illustrated in Fig. 1 may be replaced by two electron discharge devices 1a and 1b. The device 1a includes cathode 2a, heater 3a, grid 4 and anode 6 and the device 1b includes cathode 2b, heater 3b, grid 5 and anode 7. In case two tubes 1a and 1b are used the small condenser 1c, which corresponds to the inter-electrode capacity 1c of Fig. 1 is connected between the anodes 6 and 7 of Fig. 2.

The operation of the apparatus shown in Figs. 1 and 2 is substantially the same. The variable circuit components are adjusted in such a way that the oscillation generator, including the anode

6, grid 4 and cathode 2, does not generate oscillations except when the circuit between the terminals A and G is properly adjusted or closed. It is, of course, obvious that any one or more of many forms of control may be used in conjunction with this circuit and that the condensers 14 and 15 may be removed or adjusted to compensate for the different forms of control.

In practice it has also been found that the small choke coil 12, connected across the condenser 12, must be of a certain size in order that proper sensitivity for the production of oscillations be obtained.

The circuit of the oscillation generator section 15 of the electron discharge device 1 is adjusted by properly proportioning the circuit components including the choke coil 12, variable condensers 15, 17 and 21 and the resistor 8 so that a certain variation in the electrical capacity of the plates connected to the terminals A and G, causes the discharge device to generate electrical oscillations.

The electrical oscillations produced by the generator section of the tube 1 are amplified by the second section, including the electrodes 2, 5 and 7 and the electro-magnetic relay 23, which is connected to the anode 7 of tube 1 and is matched in impedance characteristics to operate efficiently in conjunction with the amplifier tube section, is controlled in accordance with the oscillations produced and amplified by the tube.

The oscillation generator section of the tube 1 operates to generate oscillations only during the period in which the capacity of the plates connected between the terminals is changed by the presence of a foreign body. It is, of course, possible that the tube could be controlled to stop generating oscillations when the foreign body is adjacent to the plate or plates, rather than start the generation of oscillations and such results may be obtained by proper circuit adjustment whereby the tube circuit is in an oscillatory state at all times except when the foreign body is in a predetermined location with respect thereto.

It is also desirable to shield the different parts of the apparatus properly, where instability of operation to a marked degree is encountered, as is likely if high frequency oscillations are produced.

From the foregoing it is apparent that I have described this invention in detail. However, I do not desire to limit this invention to the exact details set forth except in so far as they are defined by the following claims.

What I claim and desire to secure by Letters Patent of the United States is as follows:

1. In electrical discharge apparatus the combination of a dual electron discharge device having a cathode, a pair of grid electrodes and a pair of anodes, a balanced circuit, comprising a ring including a plurality of legs, inductance and capacity elements connected in said legs, one of the legs of said circuit being connected between said anodes and another of the legs of said circuit being connected between said grid electrodes, means for impressing a certain potential bias upon each of said grid electrodes, means for energizing the circuits of said anodes and means for causing one section of said dual discharge device, including said cathode, one of said grid electrodes and one of said anodes to generate electrical oscillations and means for causing the other section of said dual tube, including said cathode, the other of said grid electrodes and the other of said

anodes to amplify the oscillations generated by said first section of said discharge device.

2. In electrical discharge tube apparatus the combination of a dual electron discharge device having a cathode, a pair of grid electrodes and a pair of anodes, a Wheatstone bridge circuit having a plurality of legs, inductance and capacity elements connected in said bridge legs, one of said legs being connected between one of said grid electrodes and the corresponding anode of said discharge device, another of said legs being connected between the other of said grid electrodes and the corresponding anode of said discharge device, another of said legs being connected between said grid electrodes and another of said legs being connected between said anodes, means for impressing biasing potentials upon said grid electrodes with respect to said cathode and means for causing said electron discharge device to produce and amplify electrical oscillations.

3. In electrical discharge tube apparatus the combination of a pair of electron discharge devices each having a cathode, a grid electrode and an anode, a Wheatstone bridge circuit having a plurality of legs including inductance and capacity elements, connections between the grid electrodes and anodes of said electron discharge devices and the legs of said bridge circuit, means for impressing biasing potentials on said grid electrodes and means including a variable impedance element connected across two legs of said bridge for causing one of said electron discharge devices to generate electrical oscillations and means for causing the other of said electron discharge devices to amplify said oscillations.

4. In electrical discharge tube apparatus the combination of a pair of electron discharge devices each having a cathode, a grid electrode and an anode, a Wheatstone bridge circuit having a plurality of legs including inductance and capacity elements, connections between the grid electrodes and anodes of said discharge devices and the legs of said bridge circuit, means for connecting a predetermined capacity to the grid and cathode of one of said discharge devices, including a variable impedance element connected across two legs of said bridge for causing said last-mentioned discharge device to generate oscillations, means for impressing an anode potential on the anode of said last-mentioned discharge device, and means for causing the other of said devices to amplify said oscillations.

5. In electrical discharge tube apparatus the combination of an oscillation generator having input and output electrodes, an amplifier having input and output electrodes, a Wheatstone bridge circuit including a plurality of inductance and capacity units connected to form the legs thereof, one of the legs of said bridge circuit being connected between the output and input electrodes of said oscillation generator, another leg of said bridge circuit being connected between said input and output electrodes of said amplifier, means for balancing said bridge circuit to prevent said oscillation generator from generating oscillations, means to unbalance said bridge circuit to permit said oscillation generator to generate oscillations and means for causing said amplifier to amplify said oscillations.

6. Electrical discharge tube apparatus comprising in combination electrical discharge apparatus having at least two discharge paths each including a cathode, a control electrode and an anode, a source of current supply for energizing said electrical discharge apparatus, a Wheatstone

bridge circuit including a pair of inductance units and a pair of condensers connected alternately into said bridge circuit, connections for connecting said inductance units between the control electrodes of said two discharge paths and between the anodes of said two discharge paths, connections for coupling the control electrode to the anode of one of said discharge paths through one of said pair of condensers, connections for coupling the control electrode of the other of said discharge paths to the corresponding anode through the other of said pair of condensers, means for altering the external electrical characteristics of at least one of said discharge paths for generating oscillations therein, said oscillations being transferred to the other of said discharge paths through said bridge circuit and circuit control means connected to electrodes of said last mentioned discharge path.

7. An electric discharge device relay comprising a pair of electric discharge devices each having input and output electrodes, a Wheatstone bridge circuit including a plurality of legs, inductance and capacity elements connected in said legs, connections between said Wheatstone bridge and the input and output electrodes of said electric discharge devices, variable impedance means connected to the input electrodes of one of said discharge devices for controlling electric oscillations generated thereby, connections for impressing said oscillations on the input of the other of said discharge devices through selected legs of said bridge, and indicator means connected to the output circuit of said last mentioned discharge device.

8. In electrical discharge apparatus the combination of a dual electron discharge device having a cathode, a pair of grid electrodes and a pair of anodes, a balanced circuit, comprising a ring including a plurality of legs, a plurality of inductance and capacity elements connected in alternate ones of said legs, one of said legs including one of said inductance elements being connected between said anodes and another of said legs including another of said inductance elements being connected between said grid electrodes, means for impressing a certain potential bias upon each of said grid electrodes, means for energizing the circuits of said anodes and means for causing one section of said dual discharge device, including said cathode, one of said grid electrodes and one of said anodes to generate electrical oscillations and means for causing the other section of said dual tube, including said cathode, the other of said grid electrodes and the other of said anodes to amplify the oscillations generated by said first section of said discharge device.

9. In electrical discharge tube apparatus the combination of a dual electron discharge device having a cathode, a pair of grid electrodes and a pair of anodes, a Wheatstone bridge circuit having a plurality of legs, a plurality of inductance and capacity elements connected in said bridge legs, one of said legs including one of said capacity elements being connected between one of said grid electrodes and the corresponding anode of said discharge device, another of said legs in-

cluding another of said capacity elements, said last mentioned leg being connected between the other of said grid electrodes and the corresponding anode, and another of said legs being connected between said anodes, means for impressing biasing potentials upon said grid electrodes with respect to said cathode and means for causing said electron discharge device to produce and amplify electrical oscillations.

10. In electrical discharge tube apparatus the combination of a pair of electron discharge devices each having a cathode, a grid electrode and an anode, a Wheatstone bridge circuit having a plurality of legs including inductance and capacity elements, a condenser connected across two of the legs of said bridge, connections for connecting the grid electrodes and anodes of said electron discharge devices across selected legs of said bridge circuit, for intercoupling said grid electrodes and anodes, means for impressing biasing potentials on said grid electrodes and means for causing one of said electron discharge devices to generate electrical oscillations and the other of said electron discharge devices to amplify said oscillations.

11. In electrical discharge tube apparatus the combination of a pair of electron discharge devices each having a cathode, a grid electrode and an anode, a Wheatstone bridge circuit having a plurality of legs including inductance and capacity elements, connections for connecting the grid electrodes and anodes of said discharge devices across selected legs of said bridge circuit, for intercoupling said grid electrodes and anodes, means for connecting a predetermined capacity between the grid and cathode of one of said discharge devices, means for impressing an anode potential on the anode of said last-mentioned discharge device through one of the inductance elements of said bridge for enabling said discharge device to generate oscillations, connections for impressing the oscillations from said oscillation generating discharge device on the other of said discharge devices, and means for impressing grid biasing potentials on said discharge devices.

12. In electrical discharge tube apparatus the combination of an oscillation generator having an input and an output electrode, an amplifier having an input and an output electrode, a Wheatstone bridge circuit including a plurality of inductance and capacity units connected to form the legs thereof, one of the legs of said bridge circuit being connected between the input and output electrodes of said oscillation generator, a second leg of said bridge circuit being connected between said input and output electrodes of said amplifier, a third leg of said bridge circuit being connected between an input electrode of said oscillation generator and an input electrode of said amplifier, a fourth leg of said bridge circuit being connected between an output electrode of said oscillation generator and an output electrode of said amplifier, means for energizing the circuits of said oscillation generator and said amplifier and means for controlling the generation of oscillations by said oscillation generator.

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