

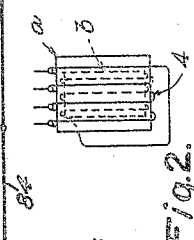
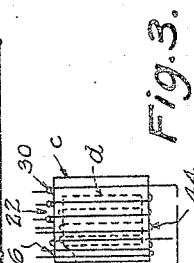
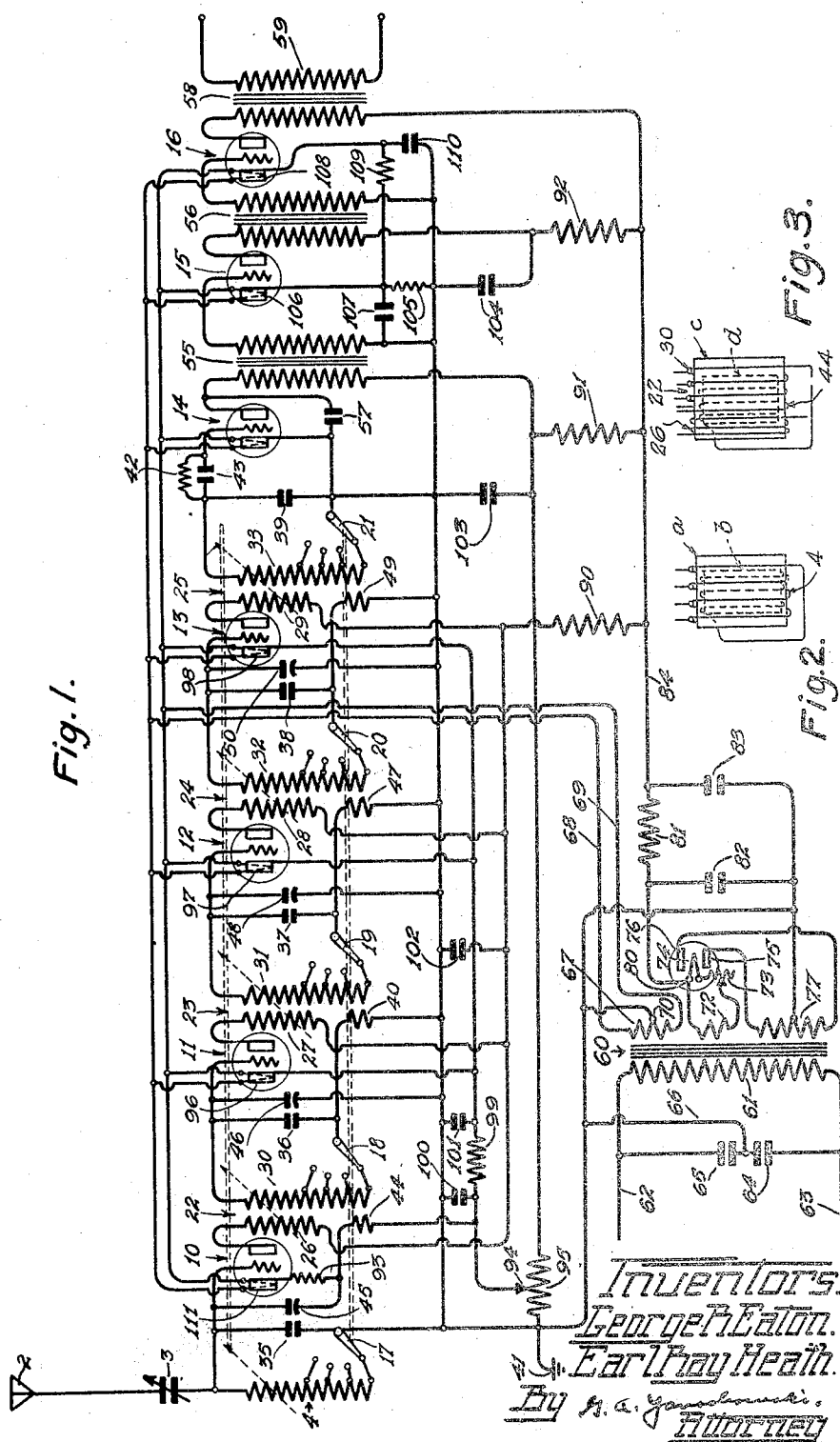
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RECEIVING CIRCUIT

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RECEIVING CIRCUIT

Application filed June 30, 1927. Serial No. 202,492.

Our invention relates to radio receiving circuits and an object of the same is the provision of an improved circuit arrangement of the type provided with radio frequency amplification.

A feature of our invention is the provision of an inductively controlled radio frequency amplifying circuit receiving its operating power from a source of alternating current. 10 A further feature of our invention is the provision of means in association with an audion tube for providing a variable grid bias for said tube when such tube is used in association with a source of alternating current 15 supply.

Another feature of our invention is the provision of a receiving set having tubes using a source of alternating current supply for furnishing the cathodes of the tubes with 20 heating current, the plates of the tubes with plate current and the grids of part of the tubes with a variable grid potential.

Another feature of our invention is the provision of a variable grid potential means for 25 controlling the volume output of our inductively controlled receiving circuit using audions of the alternating current type.

Still another feature of our invention is the provision of an inductively controlled radio 30 receiving circuit having its first stage directly connected to the oscillation collector.

Another feature of our invention is the provision of balancing means in conjunction with an inductively controlled radio receiving set 35 using a complete alternating current source of supply.

A still further feature of our invention is the provision of an inductively controlled radio receiving circuit operating from a source 40 of alternating current supply and having a variable resistance in association with the cathodes of certain of the audion tubes for providing a variable grid bias for controlling said audion tubes.

Another feature of our invention is the provision of an inductively controlled radio amplifier having stages of different character 45 and multiple controlled inductance devices for such stages.

For a better understanding of our inven-

tion reference may be had to the following description in connection with the accompanying drawings, in which

Fig. 1 diagrammatically illustrates a radio receiving circuit embodying our invention, 55

Fig. 2 diagrammatically illustrates a variable inductance used with our invention, and

Fig. 3 diagrammatically illustrates a transformer used with our invention. 60

Referring to the drawings it will be noted that we illustrate a radio receiving circuit including inductively controlled radio frequency amplification, detection and audio 65 frequency amplification.

The entire power used for the set is derived from a source of alternating current without the use of any batteries whatever.

The audion tubes 10, 11, 12, 13, 14, 15 and 16 are of the type in which the cathode is rendered active by means of a heater resistance 70 connected to a source of alternating current. Each tube comprises a cathode, provided with a coating to increase the electron emission, a heater wire, a grid and a plate. The 75 heaters are not directly electrically connected with the cathodes. For a further understanding of the construction of such a tube reference may be had to co-pending application S. N. 225,053, filed October 10, 1927. 80

The radio frequency amplifying system is of the inductively controlled type in which the tap switches 17, 18, 19, 20 and 21 are gang or multiple controlled and the rotors of the couplers and inductance 4 are gang or multiple controlled. The multiple control 85 switches change the inductance of the windings by steps and the rotors of the coils, which are multiple controlled, control the inductance continuously between steps. For 90 a more complete understanding of the construction and functioning of such apparatus reference may be had to co-pending application S. N. 26,835, filed April 30, 1925.

The character 2 represents the ordinary antenna or collector device which is connected 95 through a compensating condenser 3 to the variable inductance 4. The variable inductance 4 consists of a stator portion and a rotor portion. The stator portion includes the 100

portion of the winding which is tapped and connected to contact points, which points cooperate with the wiper 17. The rotor portion includes a part of the winding and is rotatably adjustable to further change the inductance of the winding 4. The compensating condenser 3 may be used to adjust the set to different lengths of aeri-als and after once set for a certain aerial need not be thereafter adjusted.

The couplers or transformers 22, 23, 24 and 25 comprise primary windings 26, 27, 28 and 29 and secondary windings 30, 31, 32 and 33. The couplers or transformers include a stator upon which the primary winding is wound and part of the secondary winding, the balance of the secondary winding being wound upon the rotor. The rotors are multiple controlled along with the rotor of the inductance 4. The balance of the secondary winding is included on the stator in inductive relation to the primary winding, and part of the secondary winding on the stator is tapped and connected to terminal points for cooperation with the contact wiper. The contact wiper 17 of the inductance 4 and the contact wipers 18, 19, 20 and 21 are multiple controlled by a single device.

Figs. 2 and 3 respectively illustrate diagrammatically the structure of variable inductance 4 and transformer 22. The variable inductance 4 consists of a stator *a* and a rotor *b* adapted to be rotated within the stator *a*. The portion of the winding on the rotor is connected to the portion of the winding on the stator. Part of the winding upon the stator is provided with taps for cooperation with the switch wiper 17. The transformer 22 comprises a stator portion *c* and a rotor portion *d*. The stator portion supports the primary winding 26, the balancing winding 44 and part of the secondary winding 30 which winding is provided with taps for cooperation with the switch wiper 18. The remaining portion of the secondary winding is supported by the rotor tube *d*.

Bridged across the inductance 4 to the wiper 17 is a condenser 35 and bridged across the secondaries 30, 31, 32 and 33 are condensers 36, 37, 38 and 39, said condensers being connected from one side of the secondary winding to the adjustable contact wiper which controls the effective amount of the secondary winding in use. With this method of tuning the wipers are adjustable to divide the wave band into wave zones and the rotors of the devices change the inductance of the same to tune in stations in the different wave zones. Condensers 35, 36, 37, 38 and 39 are preferably made variable, but after once they are adjusted to line up the stages, they are locked in their adjusted positions and do not need to be thereafter changed. The tuning in of stations is entirely accomplished by moving the multiple controlled switch levers

to make contact with their switch points of a desired wave zone and thereafter the multiple controlled rotors are operated to bring in the desired station. The volume of the signal reproduced is controlled by moving the wiper 94 over resistance 95 to control the grid bias of the tubes 10, 11, 12 and 13.

Tapped between the condenser 3 and inductance 4 is a connection leading to the grid of audion tube 10. The plate of said audion tube is connected through the primary of coupler 22 to the positive side of the plate current supply. The secondary of coupler 22 is connected to the grid of tube 11, and through tertiary winding 40 to ground 41. The other radio frequency stages are connected in a like manner except that the connection from the secondary of coupler 25 to the grid of tube 14 includes a grid leak 42 and a grid condenser 43 and no balancing winding. The winding 44 of transformer or coupler 22 and the condenser 45 are connected in a balanced bridge circuit to prevent inherent feed-back and oscillation. Likewise, the winding 40 and condenser 46 are used for the same purposes in connection with the audion 11. The winding 47 and condenser 48 of audion 12 and the winding 49 and condenser 50 associated with audion 13 are used for the same purposes. After the Wheatstone bridge circuits are once balanced by adjusting the balancing condensers, these condensers are locked in place and need not thereafter be adjusted. While I have shown only one ground connection it is understood a plurality of ground connections may be used, and the shielding of the set grounded.

The transformers 55 and 56 are audio frequency transformers having iron cores and are used in conjunction with the audion amplifier tubes to produce audio amplification. The condenser 57 is a by-pass condenser. The plate of audio tube 16 is connected through the winding of an iron core transformer 58 to the positive side of the B or plate supply. The secondary 59 of transformer 58 is connected to the loud speaker device.

Referring to the apparatus shown in the lower left hand corner it comprises an iron core transformer 60 having a primary 61 connected across a source of alternating current (not shown) by means of its conductors 62 and 63. Bridged across the conductors 62 and 63 are condensers 64 and 65, the center tap of which is connected by means of conductor 66 to ground 41. These condensers drain off disturbing noises which may come in over the alternating current power leads. The transformer 60 is provided with a secondary winding 67 which supplies a step down voltage to the heater elements of the different audion tubes over leads 68 and 69. The center point 70 of this secondary winding is grounded at 41 for eliminating disturb-

ances. The secondary winding 72 is connected through a variable resistance 73 to the filament or cathode of a rectifier device 74. The full wave rectifier 74 has a pair of plates 75 and 76 connected to the opposite terminals of secondary 77. The central point of secondary 77 is connected to ground 41 and forms the negative terminal of the plate current supply. Connected to one terminal of the filament of the rectifier device 74 at 80 is the positive B supply lead which extends through a choke coil 81 and which in cooperation with condensers 82 and 83 filter the B supply which is connected from conductor 84 to the plates of the audion tubes. As the manner of rectifying and filtering the B supply to reduce the variations in the rectified or uni-directional current is well known it will not be further described.

The plates of audion tubes 10, 11, 12 and 13 are connected through the primary windings of couplers 26, 27, 28 and 29, and through resistance 90 to the direct current B supply lead 84. The resistance 90 reduces the voltage of the current connected to the plates of audion tubes 10, 11, 12 and 13 to a predetermined voltage. The plate of the audion tube 14 is connected through the resistance 91 to the B supply lead 84, and the resistance 91 acts to reduce the voltage of the plate current to a predetermined value.

The plate of audion tube 15 is connected to the primary of audio transformer 56 and through resistance 92 to the B supply lead 84, and the plate of audion tube 16 is connected through the primary of audio transformer 58 directly to the full voltage supply lead 84.

The cathode of tube 10 is connected through resistance 93 of a predetermined value to the wiper 94 associated with resistance 95. The cathodes 96, 97, 98 of audion tubes 11, 12 and 13 are connected through a resistance 99 to the wiper 94, associated with resistance 95. By-pass condenser 100 is connected across from the one terminal of the resistance 99 to ground and by-pass condenser 101 is connected from the other terminal of resistance 99 to ground. Condenser 102 is connected from ground to one terminal of resistance 90. Condenser 103 is connected from one terminal of resistance 91 to ground and condenser 104 is connected from one terminal of resistance 92 to ground. A resistance 105 is connected between cathode 106 of audion tube 15 and ground 41, and condenser 107 is connected between cathode 106 and ground 41. The cathode 108 of tube 16 is connected through resistances 109 and 105 to ground 41, and the condenser 110 is connected between cathode 108 and ground 41.

Cathode 111 of tube 10 being connected through resistance 93 and variable resistance 95 to ground the potential of cathode 111 is raised with respect to the potential of

the grid, thus making said cathode positive with respect to the grid of the tube 10 thereby providing a negative grid bias. The grid return of audion tubes 11, 12 and 13 are connected to ground and as the cathodes of these tubes are connected through resistance 99 and variable resistance 95 to ground the cathodes of said tubes are positive with respect to the grids of tubes 11, 12 and 13 giving to the tubes a negative grid bias. The cathode of tube 14 is connected directly to ground as audion 14 is the detector. Since the cathode of tube 10 is connected through resistance 93 to the wiper 94 and the cathodes of tubes 11, 12 and 13 are connected through resistance 99 to the wiper 94, which may be adjusted relative to resistance 95, the difference of potential between the grids and cathodes of these tubes may be varied so as to provide a variable negative grid bias for the grids of the tubes 10, 11, 12 and 13. The resistance 105 connected between the cathode 106 of tube 15 and ground provides the necessary negative bias for the grid of tube 15 and the resistance 109 provides the necessary grid bias for the grid of the tube 16. With this arrangement the usual "C" batteries for providing the necessary grid bias are eliminated and the biasing is accomplished by the said resistances.

The means for varying the resistance in the cathode circuits of audions 10, 11, 12 and 13 provides means for varying the volume output of the receiving circuit. This means provides a very efficient and desirable method of controlling the volume output of a set using tubes of the character described above.

It being remembered that the switch wipers 17 to 21 inclusive change the inductance in comparatively coarse steps while the rotors of inductance 4 and transformers 26, 27, 28 and 29 vary the inductance within the steps of inductance between taps, to tune in a station of a predetermined frequency and wave length, the wipers are set on the contact points which include the wave length of the band within which the desired signal appears. Then the inductance of the windings is varied minutely by the rotation of the rotors of the coils until the combination of the inductances and bridge condensers are such as to permit the frequency of the desired wave length to pass through the set and be amplified. The wiper 94 is adjusted to regulate the grid bias of tubes 10, 11, 12 and 13 until the desired volume of the received signal is produced.

On the longer wave lengths the coupling between the primary windings on the stator and the secondary windings is increased so that the amplification will be constant over the entire wave band. It is not believed necessary to amplify in detail the manner in which the incoming oscillations are received by the collector 2 and are amplified by the receiving circuit, other than to state that the oscillations are directly operative upon

the grid of the tube 10, which is connected directly to the aerial or collector device, and from the tube 10 the oscillations are effective upon succeeding tubes through the inductively controlled transformers 22, 23, 24 and 25 until they are detected by the audion tube 14 and are thereafter amplified through the audio transformers and pass through the iron core transformer 58 to the coil of the loud speaker device.

Referring to the drawings it will be noted that the balancing circuit of the first stage is different from the balancing circuit of the other stages. In the first stage the input circuit is from the aerial 2 through the grid 112 to the cathode 111, and balancing winding 44 is connected between ground and the cathode 111, while in the other stages of radio frequency amplification the input circuit is across the secondary 30, 31 or 32 and its bridged condenser 36, 37 or 38, extending through balancing winding 40, 47 or 49 to ground and back to the cathode 96, 97 or 98, the balancing winding in this instance not being between ground and the cathode.

From the foregoing it will be apparent that we have provided a system which uses no batteries whatever. The cathodes of the audions are rendered active through the medium of heater elements connected to a source of alternating current. The anodes of the audions are supplied with a source of rectified filtered current and the grids are provided with biasing potential by means of resistances, the grid bias of certain of the tubes being variable to control the volume output of the set. The system is of the inductively controlled type having a direct feed in the first stage from the aerial to the grid of the audion tube and means are provided for multiple control by simultaneous adjustment of the several stages.

While we have illustrated and described a specific circuit arrangement in association with our invention, many other arrangements different than that described may be used, and it is therefore our desire to cover all such changes and modifications as come within the spirit and scope of the appended claims.

Having described our invention what we claim is new and desire to secure by United States Letters Patent is:

1. A radio amplifier circuit for amplifying incoming radio frequency oscillations including an audion tube for amplifying the incoming oscillations at their natural frequency, an audion tube for rectifying the said amplified incoming oscillations, an audion tube for amplifying the said rectified audio oscillations, a grid and a cathode for each of said audion tubes, a resistance connected between the grid and cathode of said radio amplifier audion for rendering said grid more negative than said cathode, a circuit

connecting the grid to the cathode of said rectifier audion, a second resistance connected between the grid and cathode of said audio amplifier audion for potentializing said grid, and a third variable resistance connected between the grid and cathode of said radio amplifier audion to vary the difference of potential between the said grid and cathode of said radio amplifier audion.

2. A cascade amplifying circuit including a radio amplifier, a detector and an audio amplifier for amplifying and demodulating incoming oscillations, each of said amplifiers and said detector including a cathode, a grid and an anode, a source of alternating current, a heater for each of said cathodes connected to said source of alternating current, rectifying means receiving current from said source of current and furnishing unidirectional current to said anodes, a grounded circuit connected to each of said grids, a resistance connected between the cathode of said audio amplifier and said grounded circuit for potentializing the grid of said audio amplifier, a resistance connected between said grounded circuit and one terminal of the uni-directional source of current, and another resistance connected between the cathode of said radio amplifier and said second resistance for varying the potential of the grid of the radio amplifier relative to the cathode of the radio amplifier.

3. A cascade receiving arrangement involving a plurality of stages of radio frequency amplification including audion tubes provided with indirectly heated cathodes and transformers connected to the terminals of said audion tubes, an oscillation receiver connected directly to the grid of one of said tubes and to an impedance, means for varying the inductance of said transformers and of said impedance to resonate the amplifier to receive signals of desired frequencies, a source of alternating current, a transformer connected thereto, a winding for said transformer supplying current to heat the cathodes of said tubes, a rectifier device, a second winding for said transformer supplying current to said rectifier device, said rectifier device producing plate current for the anodes of said audion tubes, and resistances including a variable resistance connected between elements of said tubes and to said source of plate current to provide potentials for the grids of said audion tubes.

4. An amplifying circuit including an audion tube having an indirectly heated cathode, an anode and a grid for said tube, a heater for rendering said cathode operative, a source of alternating current connected to said heater for rendering the same active, an inductance bridged by a condenser connected between said grid and ground, a balancing winding connected between the cathode and said ground, a condenser connected between

said cathode and said grid, said winding and condenser operating to prevent feed-back from said anode to said cathode, and a variable resistance connected between said grid and cathode for varyingly potentializing said grid with respect to said cathode.

5. A cascade receiving circuit including a plurality of audion tubes and transformers connected together to form a radio amplifier, an inductance, an aerial circuit connected directly to a grid of one of said tubes and to said inductance, primary and secondary windings for said transformers, condensers bridged across said secondary windings and said inductance, means for simultaneously varying the inductance of said secondary windings and of said inductance connected to said aerial to resonate the radio amplifier to desired frequencies, a source of alternating current, means for supplying current from said source to the cathodes of said audion tubes to render the same operative and to provide plate current for the plates of said audion tubes, a resistance connected to elements of said tubes and to said source of plate current for establishing a difference of potential between the grids and cathodes of said audion tubes, and means for varying said resistance to vary said difference of potential between the grids and cathodes of certain of said tubes.

6. A cascade three section amplifier circuit including a radio amplifier, a detector and an audio amplifier, a transformer and an audion tube included in the radio amplifier, said audion tube being connected to a winding of said transformer, a transformer and an audion tube included in said detector, said audion tube being connected to a winding of said transformer, a transformer and an audion tube included in said audio amplifier, said tube being connected to a winding of said transformer, a cathode for each of said audion tubes, a source of alternating current, a transformer connected to said source of current and having a winding supplying current to heaters for said cathodes, a rectifier connected to a winding of said last transformer and supplying current to the plates of said audion tubes, a ground circuit connected to one side of said plate current, a circuit extending from the grid of the radio amplifier tube through a winding of transformer associated therewith to said grounded circuit, a variable resistance, a circuit extending from said grounded circuit through said resistance to the cathode of said amplifier tube for controlling the bias of the grid, a circuit extending from the grid of said detector tube through a winding of the transformer associated therewith to said grounded circuit, a circuit extending directly from said grounded circuit to the cathode of said detector tube, a circuit extending from the grid of the audio ampli-

fier tube through the transformer associated therewith to said grounded circuit, a second resistance, and a circuit extending from said grounded circuit through said second resistance to the cathode of said audio amplifier tube for potentializing the grid of said audio amplifier tube.

Signed by us at Chicago, in the county of Cook and State of Illinois, this 28th day of June, A. D. 1927.

GEORGE R. EATON.
EARL RAY HEATH.

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