March 30, 1937. H. F. ELLIOTT 2,075,513

RADIO RECEIVING CIRCUIT

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Fig. 1.

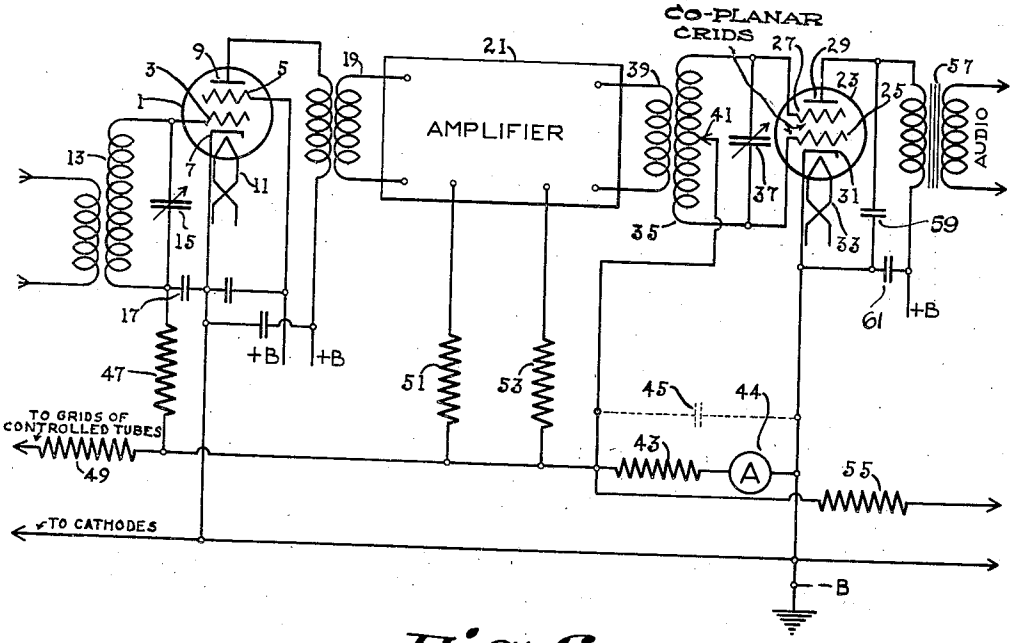
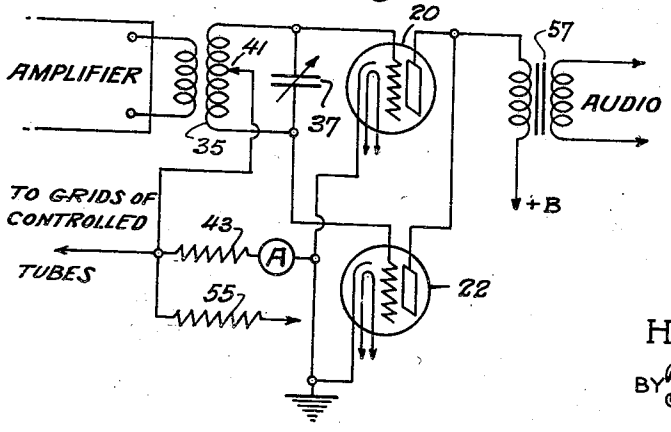


Fig. 2.



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RADIO RECEIVING CIRCUIT

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4 Claims. (Cl. 250—20)

My invention relates to radio receiving circuits of the type wherein the gain is automatically controlled in accordance with certain characteristics of an incoming signal.

Means for providing automatic gain or volume control are quite necessary in modern sensitive radio receivers to compensate the effects of fading. Heretofore, it has been customary to divert some of the signal energy, at audible or super-audible frequencies, to provide control potentials. For such purpose, since the control potentials must be uni-directional, use has generally been made of a separate rectifying device, or volume control tube, on which the signals are impressed and from which the said control potentals are taken.

Any diversion of signal energy for control purposes, however, particularly at radio frequency tends, to some extent, at least, to reduce the efficiency of reception. The additional volume-control tube, also, is obviously disadvantageous since it needs an individual cathode heating potential source for best results and requires rather critical adjustment.

It is, accordingly, an object of my invention to provide a radio receiving circuit that shall not require an extra volume control tube.

Another object of my invention is to provide, in a radio receiver, automatic volume-control means that shall not require the diversion of signal energy.

Another, and more specific object of my invention is to provide automatic volume-control means that shall not require critical adjustment.

The foregoing objects, and other objects ancillary thereto, I prefer to accomplish by deriving control potentials from direct currents that, as a result of the reception and demodulation of radio signals, normally appear in a radio receiver. Specifically, I make use of the grid-currents in a demodulator tube, when grid-detection is employed, by causing the said currents to flow through one or more resistors that are effectively included in the input circuits of certain of the amplifier tubes in the receiver.

For the mentioned purpose, I find it expedient to utilize a demodulator tube of the co-planar grid type, or two single grid tubes so disposed in circuit as to simulate the action of a co-planar grid tube. If the demodulator tube does not include one, but instead has two or more control electrodes disposed in substantially a single plane or a single surface of revolution about the cathode, the said electrodes may be connected to an equally large number of points of a circuit arrangement in which high frequency oscillations appear. Insofar as this connection is established through a grid condenser, the said grids will act by reason of the usual and well-known grid detection on the average plate current in the same sense, and insofar as audio frequency is concerned, independently of any phase difference between the said points. By an adequate choice of the points of the circuit arrangement to which the grids are connected, it is possible to create such a phase difference between these grids that so far as plate detection is concerned they will, at any instant, mutually neutralize their action either entirely or substantially.

Under such circumstances, it is possible to impress upon the grids much higher radio or intermediate frequency potentials than if an ordinary demodulator tube having only a single grid is used. The grid current, therefore, in the demodulator tube, at audio frequency, may be made much larger than the grid current from a single grid tube, and, in fact, it may be of such amplitude as to adequately supply the potential necessary for automatic volume control purposes.

The novel features that I believe to be characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of two specific embodiments when taken in connection with the drawing wherein the Fig. 1 is a circuit diagram of a portion of a radio receiver including a preferred embodiment of my invention, and Fig. 2 is a fragmentary circuit diagram showing a modification.

To avoid needless duplication, many elements such as sources of heater and plate potentials, additional amplifying stages in detail, etc. have been omitted from the diagrams. The omission of superfluous details, however, militates in no way against the completeness of the present disclosure of my invention.

Referring to the drawing, high frequency oscillations from radio frequency or intermediate frequency amplifying stages (not shown) are impressed upon the input circuit of an amplifying device 1. The amplifying device, which is illustrative merely and which may, of course, be replaced by a plurality of devices, hereinafter generically termed "repeaters" is preferably of the screen grid type having a control grid 3, a screen grid 5, a cathode 7, a plate 9, and a cathode heater 11.

The input circuit may include an inductor 13 shunted by a tuning condenser 15, the terminals of the inductor connecting, respectively, to the control grid direct and to the cathode through a by-pass condenser 17.

The amplifying tube is provided with an output circuit of any desired type, exemplified in the drawing by an inductor 19, from which potentials may be impressed upon an amplifier 21 and, eventually, upon a demodulator tube 23.

The demodulator tube, with which my invention is more intimately concerned, is of the coplanar grid type, having a plurality of grids 25 and 27, a plate 29, a cathode 31, and a cathode heater 33. Obviously, the demodulator may be of the plain filament type, if desirable. Furthermore, two demodulator tubes, connected in push-pull relation, may be substituted for the single tube, provided the plate circuits thereof are connected in parallel.

The demodulator tube is provided with an input circuit constituted by an inductor 35, shunted by a tuning condenser 37, the terminals of the inductor being connected, respectively, to the grids 25 and 27 of the tube. The input circuit is coupled to the amplifying stages (not shown) in any desirable way, as exemplified in the drawing by an inductor 39.

A connection 41 extends from an intermediate point on the input inductor of the demodulator tube to the cathode thereof and, in this connection, is preferably disposed an impedance device which may be a resistor 43, as shown in the drawing, and a sensitive micro-ammeter 44. The ammeter serves as a tuning indicator, maximum deflection thereof showing that the system is correctly tuned. The impedance device may be shunted by a condenser 45 in order that the time constant of the circuit shall be sufficiently great to prevent rapid carrier amplitude variations caused by modulation from exerting any volume control action.

The end of the resistor connected to the midpoint on the input inductor of the demodulator tube is also connected to the grid-circuit of the amplifier tube 1 through a resistor 47, and it may be connected to the grid-circuits of other tubes over which control is desired, through resistors 49, 51, 53, and 55 individual thereto.

The demodulator tube is provided with any suitable output circuit whereby potentials at audio frequencies may be impressed upon succeeding stages, as exemplified in the drawing by an audio frequency transformer 57.

It is to be noted that the primary winding of the audio frequency transformer is shunted by a plurality of radio frequency by-pass condensers 59 and 61. These condensers, while theoretically not necessary, are illustrated as being desirable in the event that perfect balance is not obtained in the tube itself.

It will also be noted, from an inspection of the drawing, that I have omitted any grid condensers from the demodulator input circuit. The omission of such condensers does not militate against operation of the system, however, for the reason that the grid-cathode capacity takes their place.

In the operation of my improved automatic volume control circuit, amplified oscillations at radio or intermediate frequency are impressed upon the grids of the demodulator tube 23. The average potentials of the several grids during the passage of a wave train fall to an equal extent, whereby they function in parallel, so to speak, and mutually aid one another in causing a diminution of the plate current. The charge acquired by the grid-cathode capacities, after the passage of any given wave train, leaks off through the resistor 43 included between the cathode and the input inductor, at a rate determined by the grid-cathode capacities and the magnitude of the resistor. In one embodiment of my invention the resistor, preferably, has a value of one half to five megohms and is not at all critical.

The grid-current flowing in the resistor causes the cathode end thereof to assume a potential which is positive with respect to the end connected to the grids of the controlled tubes. The magnitude of the potential is a function of the grid current. The grid current, obviously, is a function of the amplitude of an incoming signal or carrier current and, accordingly, the greater the amplitude, the more negative will the grids of the controlled tubes become with respect to their cathodes. Such being the case, a signal at increased amplitude is met by an amplifier wherein the gain is reduced, with the result that the output from the entire receiver at audio frequency is constrained to remain at substantially a constant level.

Attention has already been called to the fact that the omission of grid condensers does not affect the operation of the system. Such condensers may, however, be utilized, in which event each of the grids is provided with an individual grid leak and the potentials developed across these grid leaks may be utilized for volume control purposes in any suitable manner. Since such modification is obvious, it has not been illustrated.

It should also be clearly understood that my invention is not limited to the application of control potentials to the high frequency amplifying stages alone. In certain instances, it may be desirable to apply the control potentials to the audio frequency amplifier or to relays and the like which function to suppress audio output from the system during the tuning thereof between stations.

In short, any radio receiver, amplifier, or the like wherein a coplanar grid tube or a plurality of tubes jointly functioning as a coplanar grid tube are utilized as a detector, thus permitting the impression thereon of high input potentials, and wherein means are provided for utilizing the grid current in such a tube for control purposes, falls within the spirit of my invention.

Thus, as shown in Fig. 2, I may, if desired, employ two ordinary triode tubes 20 and 22, the grids of which are connected in circuit with the secondary winding 35 in the same manner as is shown in Fig. 1 with reference to the connection of the input circuit including the co-planar grids 25 and 27. The embodiment of Fig. 2 will be seen to be in all other respects similar to the embodiment hereinbefore shown and described with reference to Fig. 1.

It should be apparent, from a consideration of the foregoing description of a receiving system embodying my invention, that it has numerous advantages. The coplanar grid tube lends itself admirably to power detection. It is not paralyzed by strong signals from nearby stations and, for that reason, it may always be relied upon to provide the necessary grid current for control purposes. Furthermore, since the radio frequency component of the plate current is substantially neutralized, the tube is much more efficient as a detector than ordinary single grid tubes and this condition also contributes to

a large and constant grid current during signal reception. Obviously, the elimination of a separate volume control tube and circuit elements of necessity associated therewith is advantageous from the standpoint of economy.

My improved circuit is also advantageous, as hereinbefore pointed out, in that no signal energy is diverted for volume control purposes. The grid current is present as a matter of course and its utilization to control the grid potentials of other amplifying tubes does not lower the efficiency of the system in the slightest.

Although I have illustrated and described two preferred embodiments of my invention, many modifications thereof will at once be apparent to those skilled in the art. My invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a signaling system, a plurality of repeaters, means to supply alternating current to the input circuits of said repeaters, at least one of said repeaters including a cathode electrode and a plurality of grids so arranged as to mutually substantially neutralize their action so far as plate-detection is concerned, a tuned input inductor for said last named repeater having terminals connected with two of said grids and an intermediate tap connected with the cathode electrode, means including a resistor in said last named connection to vary the uni-directional potential normally present in said grid circuit in accordance with the envelope of the alternating input energy applied thereto, and means for utilizing said varying uni-directional potential to control the gain in said system.

2. In a radio receiving system, the combination with a signal amplifier including an electric discharge amplifier device having a cathode and a signal input grid, of a demodulator of the co-planar grid type having a pair of co-planar grids, a cathode and an anode, a tunable signal input inductor having terminals connected each with one of said grids and having an intermediate tap point connected with the cathode, a potential drop producing impedance in the last named connection whereby it is in circuit common to both of said grids, an output circuit for demodulated signals connected with the anode, and a bias supply connection between the signal grid of said amplifier and said potential drop producing impedance.

3. In a radio signal receiving system, means providing automatic volume control potentials therefor without diverting signal currents, said means comprising a signal demodulator stage including an electric discharge device having a cathode, a pair of co-planar grids and an output anode, a tunable signal input inductor for said demodulator stage having its terminals connected each with one of said grids and having an intermediate tap point thereon, a resistor common to both of said grids connected between said tap point and the cathode, a modulation signal output circuit connected with said output anode, and an automatic volume control circuit connected with said impedance.

4. In a radio signal receiving system, means providing a push-pull detector comprising a pair of control grids, a signal input inductor connected between said grids, means for tuning said inductor to an incoming signal wave, a resistor connected to an intermediate tap point on said inductor in circuit common to both of said grids, and means for deriving the rectified modulation component of the signal current flowing in said resistor to control the signal amplification in said system.

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