June 13, 1939. D. G. LITTLE 2,162,535

NEUTRALIZING CIRCUIT

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Fig. 1.

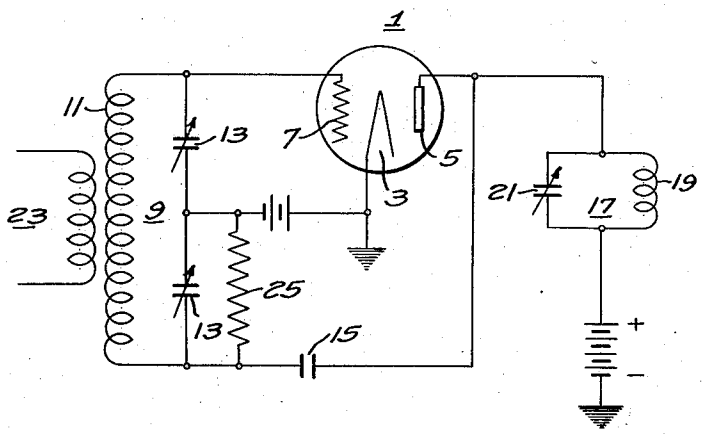
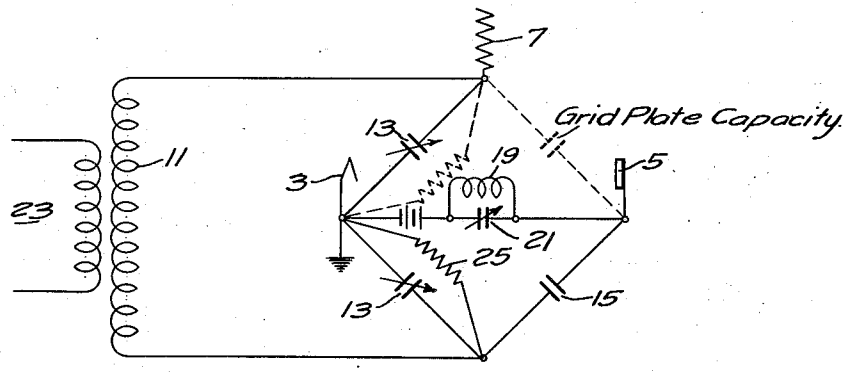


Fig. 2.



WITNESSES:

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NEUTRALIZING CIRCUIT

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3 Claims. (Cl. 179—171)

My invention relates to radio circuits and more particularly to means for improving the neutralizing thereof.

One well known arrangement for neutralizing radio circuits is commonly referred to as the "Rice" method as disclosed in United States Patent No. 1,334,118. In accordance with this method, the undesired feed back of energy from the output circuit of a tube to the input circuit is prevented by balancing the input circuit to the tube with a circuit which feeds back energy to the grid thereof equal in magnitude but 180° out of phase with that which reaches the grid by way of the grid plate capacity. The neutralizing arrangement referred to found wide application in practice and proved to be very efficient with amplifiers commonly known as the class A type, wherein in the normal operation the peak signal input voltages to the grid are of such value that the dynamic operating characteristics are maintained linear. In other words, the grid is not allowed to go positive on excitation peaks and the plate current does not fall to a low value to cause distortion due to the curvature of the characteristic. It has been found, however, that when attempting to neutralize circuits of a similar character in amplifiers of the class B or class C type, neutralization was difficult to obtain and parasitic oscillations were prone to develop. A study of the cause of this brought to light the fact that adequate neutralization could not be obtained because of the disbalancing effect of current present in the input circuit of the tube. It is common practice to operate class B and C amplifiers with large input signals and at positive half cycles the excitation peaks are sufficiently large to overcome the initial negative bias of the grid driving the latter positive with respect to the cathode and this results in a flow of grid current during these portions of each cycle.

This flow of current in the input circuit of the tube results in a voltage drop through the tube impedance existing between the grid or control electrode and the cathode and it, therefore, becomes necessary to consider this factor in obtaining neutralization of the feed back of energy from the plate circuit to the input or grid circuit.

It is accordingly an object of my invention to provide means for obtaining adequate neutralization of an amplifier or similar circuit wherein current flows in the input circuit during at least a portion of each cycle of the impressed grid or control potential.

It is a further object of my invention to provide means for neutralizing a circuit of the above character wherein current flows during at least a portion of each cycle of the input voltage, which means shall not require material changes in the neutralizing circuit used in connection with amplifiers of the class A type.

Additional objects of my invention will be brought out in the following description of the same, taken in connection with the drawing, wherein

Figure 1 is a circuit diagram of an amplifier circuit embodying the teachings of my invention, and

Fig. 2 is an equivalent circuit represented in the form of a bridge network to illustrate more clearly the theory underlying the operation of my invention.

In the circuit of Fig. 1 is shown an electron discharge device 1 having a cathode 3, anode 5 and control electrode 7. A tuned circuit 9 comprising a parallel arrangement of inductance and capacity which, in the specific example illustrated, comprises an inductor 11 shunted by a pair of serially connected condensers 13, has its electrical mid-point connected to the cathode of the tube. The control electrode is connected to one terminal of the tuned circuit, the other terminal thereof being connected to the anode of the tube through a condenser 15 having a capacity substantially equal to that existing internally between the control and plate electrodes of the tube. The output circuit of the amplifier, which may comprise a tuned circuit 17 in which the inductance 19, shunted by a condenser 21, may comprise the primary winding of a coupling transformer, is connected one terminal of which to the plate electrode and the other to the positive terminal of a power supply source, the negative terminal of which may be grounded together with the cathode of the tube.

Where the amplifier is to be employed as a class B or class C amplifier, it will normally be biased either to cut-off or beyond, and the amplifier will be fed from a source of excitation potential 23 of such magnitude as to cause the control electrode of the tube to swing positive during a portion of each cycle of applied excitation voltage. To compensate for the unbalancing effect of tube impedance between the cathode and control electrodes of the tube on neutralization, and thus to enable adequate neutralization of the circuit against the feed back of energy from the plate or output circuit, I provide an impedance 25 in shunt to that portion of the tuned input circuit between the cathode and that end to which the condenser is connected, this im-

pedance to be of the order of that existing between the cathode and control electrodes.

Referring to the equivalent circuit of Fig. 2, the manner in which this added impedance operates to complete the circuit and enable it to neutralize properly in spite of the flow of current in the grid circuit, will be more readily apparent than from a study of the amplifier circuit of Fig. 1. In this equivalent circuit, the various elements have been designated by the same reference characters as have been employed in designating the corresponding elements in the circuit of Fig. 1, and the impedance of the tube between the cathode and control electrodes has been indicated in broken lines. It will be apparent from a brief examination of the circuit of Fig. 2, that a balanced bridge work has been completed by the addition of the impedance across that portion of the tuned circuit referred to above.

It will thus be apparent that energy fed back from the plate circuit to the grid electrode by way of the grid plate capacity of the tube will be completely neutralized by reason of the energy of similar magnitude but of opposite phase relationship being fed back from the plate or anode by way of the condenser 15 to the grid of the tube, regardless of whether such energy travels by way of the condensers in the tuned input circuit or the tube impedance shunting one of these condensers or the matching impedance shunting the other condenser.

It will thus be apparent that my invention fulfills the objects set forth and while I have disclosed it in great detail, various changes might be made without departing from the scope thereof, and I, therefore, do not desire to be limited to such details except as may be necessitated by the prior art and the appended claims.

I claim as my invention:

1. A neutralizing circuit comprising an electron diacharge device having cathode, anode and control electrodes, a tuned circuit comprising a parallel arrangement of inductance and capacity, a connection from said cathode to the electrical midpoint of said tuned circuit, means connecting said control electrode to one terminal of said tuned circuit, a condenser having a capacity substantially equal to the internal capacity between said control electrode and said anode, said condenser being connected in circuit between said anode and the other terminal of said tuned circuit and an impedance conductive to direct current and substantially equal in value to the internal impedance between said grid and cathode connected between said electrical midpoint and said last mentioned terminal.

2. In a class B or class C amplifying stage operating at high input signal levels wherein during normal operation grid current flows tending to alter the internal tube impedance, neutralizing circuit comprising an electron discharge device having cathode, anode and control electrodes, a tuned circuit comprising an inductance shunted by a pair of serially connected condensers, a connection from said cathode to the electrical midpoint of said tuned circuit, means connecting said control electrode to one terminal of said inductance, a condenser having a capacity substantially equal to the internal capacity between said control electrode and said anode, said condenser being connected in circuit between said anode and the other terminal of said tuned circuit and an impedance substantially equal in value to the altered condition of the internal tube impedance between said grid and cathode due to said current connected between said electrical midpoint and said last mentioned terminal.

3. A neutralizing circuit comprising an electron discharge device having cathode, anode and control electrodes, a tuned circuit comprising a parallel arrangement of inductance and capacity, a connection from said cathode to the electrical midpoint of said tuned circuit, means connecting said control electrode to one terminal of said tuned circuit, a condenser having a capacity substantially equal to the internal capacity between said control electrode and said anode, said condenser being connected in circuit between said anode and the other terminal of said tuned circuit and a resistance substantially equal in value to the internal resistance between said grid and cathode connected between said electrical midpoint and said last mentioned terminal.

DONALD G. LITTLE.