

July 21, 1925.

1,547,154

A. W. HULL
AMPLIFYING APPARATUS
Filed Aug. 15, 1924

Fig. 1.

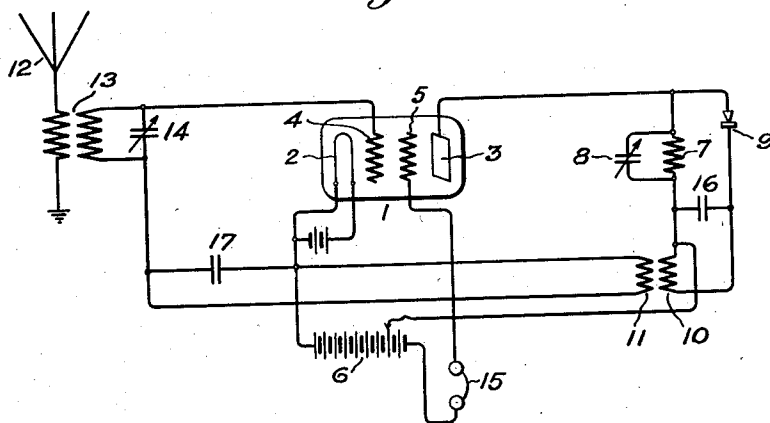
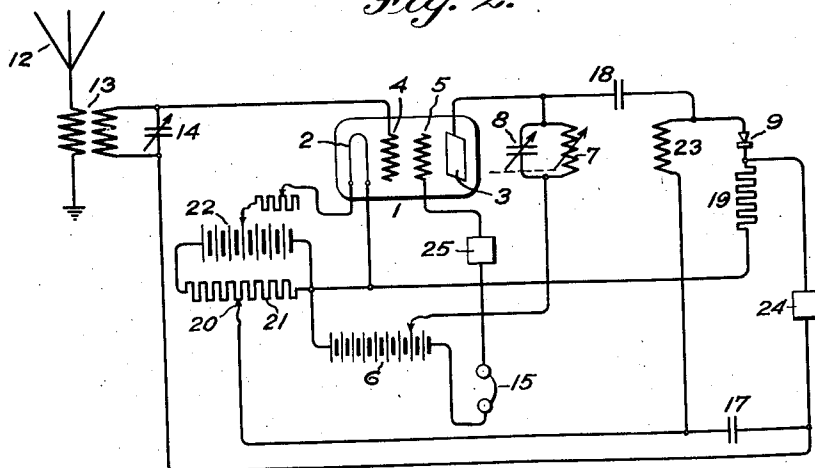


Fig. 2.



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His Attorney.

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UNITED STATES PATENT OFFICE.

ALBERT W. HULL, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

AMPLIFYING APPARATUS.

Application filed August 15, 1924. Serial No. 732,284.

To all whom it may concern:

Be it known that I, ALBERT W. HULL, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Amplifying Apparatus, of which the following is a specification.

My present invention relates to electron discharge apparatus and circuits for amplifying and detecting high frequency signaling currents. One of the objects of my invention is to provide a circuit arrangement whereby the amount of amplification which may be obtained with a single device may be greatly increased.

It has been proposed in the past to employ a three electrode electron discharge device for the simultaneous amplification of radio frequency currents and audio frequency currents. So far as I am aware however no one has heretofore proposed any practical system whereby a four electrode electron discharge device, particularly one of the negative resistance or pliodynatron type, could be employed for the simultaneous amplification of both radio and audio frequency currents.

A more specific object of my invention is to provide a circuit arrangement whereby a pliodynatron may be successfully employed to serve the two functions mentioned.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation will best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 shows diagrammatically one form of my invention and Fig. 2 shows a modification thereof.

I have indicated in the drawing an electron discharge device 1 having the usual electron emitting cathode 2, plate electrode 3 and two grids 4 and 5 interposed between cathode and plate. The grid 4 serves as a control grid and the grid 5 serves as an anode for receiving impact electrons emitted from the plate 3. A source of potential 6 which is connected in the circuits between the cathode 2 and plate 3 and grid 5 furnishes suitable values of potential for application to electrodes 3 and 5 to produce a

negative resistance in the plate circuit by reason of the emission of impact electrons from the plate 3. By suitable adjustments the negative resistance produced in this way may be made great enough to compensate for the losses of the system without at the same time causing the production of oscillations.

In the system shown in Fig. 1, the plate circuit may be tuned to the frequency of the high frequency oscillations to be amplified by means of inductance 7 and variable condenser 8. Amplified high frequency currents produced in the plate circuit are supplied to a crystal detector 9 having in circuit therewith the primary 10 of a transformer, the secondary 11 of which is included in the input circuit connected between cathode 2 and control grid 4.

I have indicated the application of my invention to the amplification and detection of high frequency signaling currents received upon an antenna 12 and supplied by a coupling transformer 13 to the tuned input circuit 14 of device 1. Received radio frequency currents are amplified by device 1, rectified by crystal detector 9 and the audio frequency currents produced by rectification supplied to the input circuit by transformer 10, 11 and also amplified. An indication of the amplified audio frequency currents may be obtained in the usual telephone receiver 15 connected in the circuit of grid electrode 5. By-pass condensers 16 and 17 are preferably provided for by-passing around the transformer 10, 11 the radio frequency components of the currents flowing in the circuit of the crystal detector and the input circuit respectively.

In the modification of my invention, shown in Fig. 2, the detector circuit instead of being conductively connected to the plate circuit is coupled thereto by means of a condenser 18. The rectifier circuit instead of being inductively coupled to the input circuit is coupled thereto by a resistance coupling, the audio frequency currents produced by rectification being caused to flow through a resistance 19 which is included in the input circuit. I have found that the most satisfactory operation of the system described may be obtained with crystal detectors which operate best when slightly polarized. In the arrangement shown in Fig. 2, the adjustable contact 20 on potentiometer

21 which is connected to battery 22 furnishes the desired polarizing potential to the crystal detector 9 through a choking inductance 23. The potential applied to the input circuit in this way also serves as a biasing potential for the control grid 4. In Fig. 2, I have indicated the inductance 7 and condenser 8 as both variable and these are preferably so arranged that tuning of the plate circuit is accomplished by simultaneous adjustment of both, as by this expedient the power factor of the plate circuit may be maintained substantially constant over a wide range of frequencies. If desired filters 24 and 25 may be provided at the points indicated to prevent high frequency currents from flowing in the circuits in which they are connected.

While I have shown and described only two modifications of my invention, it will be apparent that many modifications in the particular apparatus employed and in the manner in which it is connected in the circuit may be made without departing from the scope of my invention as set forth in the appended claims.

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

1. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said grids, sources of potential connected in the circuits between the cathode and the plate and second grid of such value that a negative resistance is produced in the plate circuit of high enough value to compensate for the losses of the system, means for tuning the plate circuit to the frequency of the high frequency currents, means for rectifying the amplified high frequency currents produced in the plate circuit, means for supplying low frequency currents produced by such rectification to the first grid circuit and means for producing an indication of the amplified low frequency currents in the circuit of the second grid.

2. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said grids, sources of potential connected in the circuits between the cathode and the plate and second grid of such value that a negative resistance is produced in the plate circuit of high enough value to compensate for the losses of the system, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected in a circuit which is coupled to the tuned plate circuit, a coupling between the circuit of the crystal detector and the circuit of the first grid and means for indicating the resultant currents produced in the circuit of the second grid.

3. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said grids, sources of potential connected in the circuits between the cathode and the plate and second grid of such value that a negative resistance is produced in the plate circuit of high enough value to compensate for the losses of the system, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected in a circuit which is coupled to the tuned plate circuit, a coupling between the circuit of the crystal detector and the circuit of the first grid, means for indicating the resultant currents produced in the circuit of the second grid, and a common means for supplying a polarizing potential to the crystal detector and a biasing potential to the first grid.

4. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said grids, sources of potential connected in the circuits between the cathode and the plate and second grid of such value that a negative resistance is produced in the plate circuit of high enough value to compensate for the losses of the system, a variable inductance element and a variable capacity element connected in parallel in the plate circuit, a single means for simultaneously adjusting both of said elements to tune the plate circuit to the frequency of the high frequency currents means for rectifying the amplified high frequency currents produced in the plate circuit, means for supplying low frequency currents produced by such rectification to the first grid circuit and means for producing an indication of the amplified low frequency currents in the circuit of the second grid.

5. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said grids, sources of potential connected in the circuits between the cathode and the plate and second grid of such value that a negative resistance is produced in the plate circuit of high enough value to compensate for the losses of the system, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected in a circuit which is coupled to the tuned plate circuit, a coupling between the circuit of the crystal detector and the circuit of the first grid, means for indicating the resultant currents produced in the circuit of the second grid, and a common means for supplying a polarizing potential to the crystal detector and a biasing potential to the first grid.

tem of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections
5 between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said
10 grids, sources of potential connected in the circuits between the cathode and the plate and second grid, means for tuning the plate circuit to the frequency of the high frequency currents, means for rectifying the
15 amplified high frequency currents produced in the plate circuit, means for supplying low frequency currents produced by such rectification to the first grid circuit and means for producing an indication of the
20 amplified low frequency currents in the circuit of the second grid.

6. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections
25 between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said
30 grids, sources of potential connected in the circuits between the cathode and the plate and second grid, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected
35 in a circuit which is coupled to the tuned plate circuit, a conductive coupling between the circuit of the crystal detector and the circuit of the first grid and means for indicating the resultant currents produced in
40 the circuit of the second grid.

7. The combination in an amplifying system of an electron discharge device having an electron emitting cathode, a plate elec-

trode and two grid electrodes interposed between cathode and plate, circuit connections
45 between the cathode and each of the other electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said
50 grids, sources of potential connected in the circuits between the cathode and the plate and second grid, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected
55 in a circuit which is coupled to the tuned plate circuit, a conductive coupling between the circuit of the crystal detector and the circuit of the first grid, means for indicating the resultant currents produced in the
60 circuit of the second grid, and a common means for supplying a polarizing potential to the crystal detector and a biasing potential to the first grid.

8. The combination in an amplifying system of an electron discharge device having
65 an electron emitting cathode, a plate electrode and two grid electrodes interposed between cathode and plate, circuit connections between the cathode and each of the other
70 electrodes, means for impressing high frequency currents to be amplified upon the circuit between the cathode and one of said
75 grids, sources of potential connected in the circuits between the cathode and the plate and second grid, means for tuning the plate circuit to the frequency of the high frequency currents, a crystal detector connected
80 in a circuit which is coupled to the tuned plate circuit, a resistance coupling between the circuit of the crystal detector and the circuit of the first grid and means for indicating the resultant currents produced in the circuit of the second grid.

In witness whereof, I have hereunto set my hand this 14th day of August, 1924.

ALBERT W. HULL.