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AMPLIFIER CONTROL CIRCUITS

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*Fig. 1*

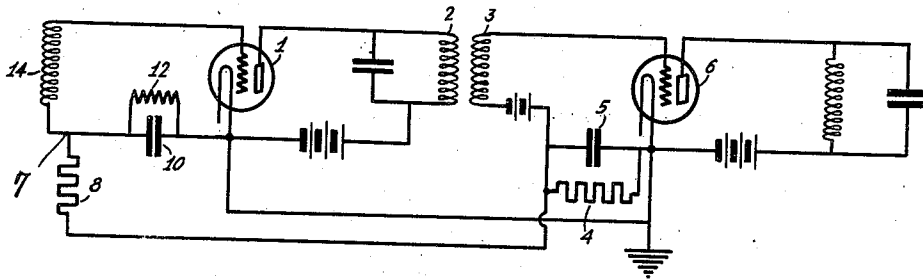


*Fig. 2*

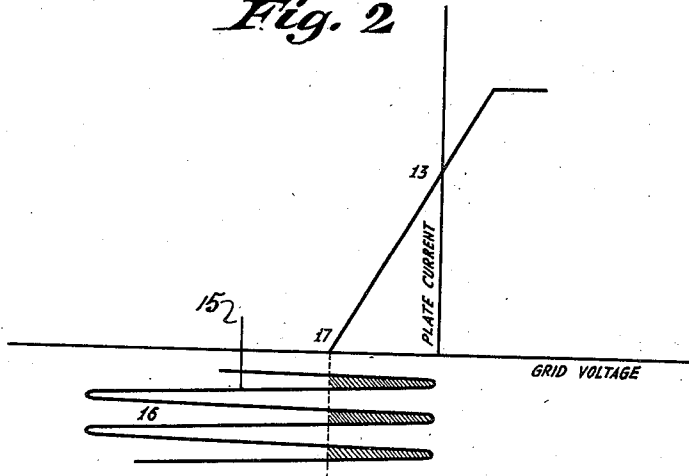
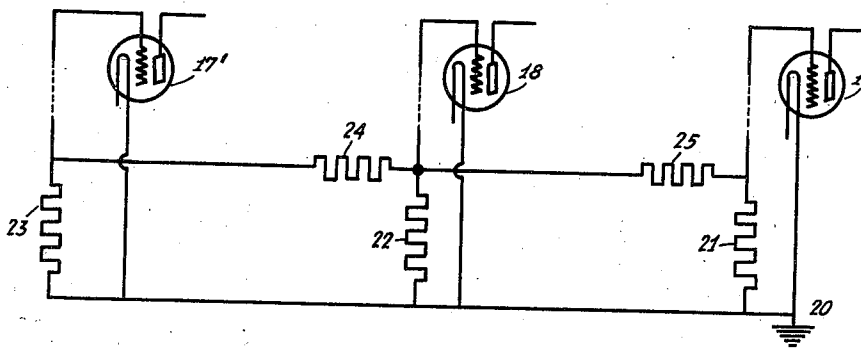


*Fig. 3*



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## AMPLIFIER CONTROL CIRCUITS

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12 Claims. (Cl. 179-171)

The present invention relates to amplifiers, and more particularly to amplifier circuits for transmitting or receiving arrangements comprising thermionic tubes.

5 With amplifiers comprising thermionic tubes adapted to supply a considerable power, it may occur that a given value of the voltages at the input side of the amplifier is attended with strong grid currents set up in one or more of the next  
10 tubes. Due to these grid currents the impedance inserted in the plate circuit of the preceding tube decreases, in consequence of which a further increase of the voltages at the input side of the amplifier is no longer attended with an appreciable increase of the output energy, but  
15 with a strong increase of the anode dissipation of the tube preceding the tube in which the grid currents occur, so that the efficiency of the amplifier falls off. Moreover, an excessive anode dissipation unfavorably influences the lives of the  
20 tubes. Especially, in the case of transmitting amplifiers, this drawback may attain undue proportions.

This invention has for its object to provide means for obviating this drawback, and is characterized by the feature that the grid currents set up in an amplifying stage are used to enhance the negative grid voltage of the tube in the preceding stage. Thus, the appearance of  
30 grid currents in some stage or other is attended with a reduced amplification of the preceding stage due to which the grid currents in the first mentioned stage are reduced without entailing an appreciable decrease of the output energy of this stage. Owing to the weak grid current the efficiency of the preceding stage keeps better,  
35 while in addition, the efficiency is favorably influenced by the increased negative grid voltage.

In case of various successive amplification stages being arranged the invention may likewise be applied several times. The negative grid voltage is acted upon by inserting a resistance, preferably at the side of the cathode, in the grid circuit of one or more of the tubes, and by connecting either the end which is not connected to  
45 the cathode or another point of this resistance, either directly or across a resistance, with a point of the grid circuit of the tube in the preceding amplification stage.

50 In amplifying circuit arrangements comprising a plurality of thermionic tubes a network of resistances may be applied, which may be formed by inserting a separate resistance between a common point of the filament circuits and each of  
55 the grids and by connecting together the grids

of the tubes mounted in the successive stages likewise across resistances. By a proper choice of the various resistances the above consequences resulting from the appearance of grid currents may substantially be suppressed.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood  
10 by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried  
15 into effect.

In the drawing,

Fig. 1 diagrammatically shows a circuit embodying the invention,

Fig. 2 graphically illustrates the operation of the circuit shown in Fig. 1,

Fig. 3 is a modified form of the invention.

Referring now to the accompanying drawing, in Fig. 1, 1 denotes a triode in whose plate circuit a tuned circuit 2 is inserted, the latter being inductively coupled with the grid circuit of a subsequent triode 6. The grid circuit of the triode 6 is formed by a choke coil 3 and a resistance 4, the latter being preferably shunted by a condenser 5. The resistance 4 is interposed between the choke coil 3 and the cathode of the triode 6. The end of the resistance 4 is connected to the point 7 of the grid circuit of the triode 1.

Between the point 7 and the resistance 4 is inserted a resistance 8. The point 7 is connected with the cathode of the triode 1 through the resistance 12. This resistance is shunted by the condenser 10. The resistance 8 may also be zero. The condenser 10 forms a path with a low impedance to the alternating current passing through the grid circuit of the triode 1. The working of the circuit arrangement shown in Fig. 1 will be explained by reference to Fig. 2.

In Fig. 2, the plate current characteristic of the triode 1 is represented by the curve 13. The grid bias of the triode 1 is supposed to be so chosen that the same is strongly negative under normal circumstances, so that in the case of an alternating current being set up in the inductance 14, only the "crests" are rendered active, this being schematically shown in Fig. 2. In this figure the direct current adjustment of the grid of the triode 1 is indicated at 15. If an alternating voltage be induced in the grid circuit, this voltage will proceed in accordance with the sine-curve 16.

The triode 1 will allow the passage of anode current as soon as the voltage exceeds the value denoted by the point 17. It will be understood that in this case, only the hatched crests of the curve 16 are active. If the amplitude of the alternating voltage represented by the curve 16, becomes larger then it may occur that a grid current is set up in the triode 6, this current flowing from the cathode through the resistance 4 through the inductance 3 to the grid and thence to the cathode. The end of the resistance 4 has consequently a negative voltage relatively to the cathode.

Since the cathodes are grounded as is generally customary with amplifiers, or at least connected together, the point 7 will acquire a higher negative value likewise relatively to the cathode of the triode 1 in the case of grid currents occurring in the triode 6. This results in that the direct current position, designated in Fig. 2 by 15, moves to the left, so that the active part of the crests 16 is reduced. Accordingly, the appearance of grid currents in the triode 6 will be counteracted and in addition no undue dissipation will occur at the plate of the triode 1.

Fig. 3 shows schematically a circuit arrangement comprising a plurality of triodes connected one behind the other, the connections which are not required for a good understanding of the invention having been removed. The various triodes are denoted by 17', 18 and 19 respectively. The cathodes of the tubes are all connected to ground at 20. The point 20 is connected to the grids of the triodes 19, 18 and 17' across resistances 21, 22 and 23, the grid of the tube 17' being connected to that of the triode 18 across a resistance 24 and the grid of the triode 18 being connected to the grid of the triode 19 across a resistance 25. By a proper choice of the resistances 21, 22, 23, 24 and 25, and by giving them suitable values the detrimental effect attended with the appearance of grid currents may be practically entirely eliminated.

It goes without saying that the invention is not limited to the circuit arrangement shown on the accompanying drawing, but may also be applied to amplifiers in which a push-pull circuit arrangement is applied, and to amplifiers in which the amplification is attended with frequency multiplication. It will be understood that in this case only slight modifications are required in order to carry the principle of the invention into effect.

What I claim is:

1. In combination, a plurality of successive electron discharge tubes, and means associated with the input circuit of a succeeding tube, and connected with the input circuit of a preceding tube to vary the grid voltage of the latter in a negative sense in accordance with grid current variation in the succeeding tube, and means for normally maintaining said preceding tube biased to at least cut-off.

2. In combination with a high frequency amplifier tube having an input circuit adapted to have electrical impulses to be amplified impressed thereon, means for normally biasing the tube beyond cut-off whereby only impulses exceeding a predetermined intensity are amplified, a following tube, a coupling network between the amplifier output electrodes and the input electrodes of said following tube, a resistor connected in the grid circuit of the following tube for producing a potential varying with the amplitude of grid current flowing in said grid circuit, said grid

current flowing only when the amplified impulses transmitted through said network exceed a predetermined level, and a conductive path connected between one side of said resistor and the input circuit of said amplifier for applying said varying potential to the amplifier circuit to vary said bias in a negative sense with the flow of said grid current.

3. In combination with a high frequency amplifier tube adapted for use in a transmitter and having an input circuit adapted to have electrical impulses to be amplified impressed thereon, means for normally biasing the tube beyond cut-off whereby only impulses exceeding a predetermined intensity are amplified, a following tube, a tuned coupling network between the amplifier output electrodes and the input electrodes of said following tube, a resistor connected in the grid circuit of the following tube for producing a potential varying with the amplitude of grid current flowing in said grid circuit, said grid current flowing only when the amplified impulses transmitted through said network exceed a predetermined level, and a conductive path connected between one side of said resistor and the input circuit of said amplifier for applying said varying potential to the amplifier circuit to vary said bias in a negative sense with the flow of said grid current.

4. In combination with a high frequency amplifier tube having an input circuit adapted to have electrical impulses to be amplified impressed thereon, means for normally biasing the tube beyond cut-off whereby only impulses exceeding a predetermined intensity are amplified, a following tube, a tuned coupling network between the amplifier output electrodes and the input electrodes of said following tube, a resistor connected in the grid circuit of the following tube for producing a potential varying with the amplitude of grid current flowing in said grid circuit, said grid current flowing only when the amplified impulses transmitted through said network exceed a predetermined level, and a resistive conductive path connected between one side of said resistor and the input circuit of said amplifier for applying said varying potential to the amplifier circuit to vary said bias in a negative sense with the flow of said grid current.

5. In combination, in a multi-stage high frequency system, a succeeding stage including a tube having an impedance connected between its input electrodes, a preceding stage including a tube having its control electrode connected to one side of said impedance, and a conductive impedance connected directly between the control electrodes of said tubes.

6. In combination, in a multi-stage high frequency system, a succeeding stage including a tube having an impedance connected between its input electrodes, a preceding stage including a tube having its control electrode connected to one side of said impedance, a conductive impedance connected directly between the control electrodes of said tubes and an additional impedance connected between the control electrode of said preceding tube and said one side of the first impedance.

7. In a radio apparatus, a controlling tube and a controlled tube, the grid of said controlling tube being connected to the cathode thereof and ground through a resistance, the ungrounded end of said resistance being connected to the grid circuit of a controlled tube, the electron emitting

device of said controlled tube being connected with said ground.

5 8. In a radio apparatus, a controlling tube and a controlled tube, the grid of said controlling tube being connected to the cathode thereof and ground through a resistance, the ungrounded end of said resistance being connected to the grid circuit of a controlled tube, the electron emitting device of said controlled tube being connected with said ground, said resistance and said grid circuit being connected through an isolating resistance.

15 9. In a radio apparatus, a controlling tube and a controlled tube, the grid of said controlling tube being connected to the cathode thereof and ground through a resistance, the ungrounded end of said resistance being connected to the grid circuit of a controlled tube, the electron emitting device of said controlled tube being connected with said ground, said resistance and said grid circuit being connected through a filtering device.

25 10. In combination, in a signalling system, a radio frequency amplifier having a signal input circuit, a following tube having at least a cathode, control grid and anode, a coupling network between the output electrodes of said amplifier and the control grid and cathode of the following tube, a resistor connected between the said grid and cathode, a direct current connection, including a resistor, between the control grid side of the first resistor and the said input circuit, for applying to the latter a negative potential developed across said first resistor by the flow of grid current whereby the gain of said amplifier is automatically varied in a direction to reduce the flow of said grid current, and the said grid being maintained sufficiently negative with respect to said cathode to prevent the said grid current flow until signals impressed between said

grid and cathode exceed a predetermined peak value.

11. In a signalling system, an amplifier including an amplification control element, a device comprising two rectifying electrodes and a third electrode, an input circuit including said two rectifying electrodes and means for transferring signals from said amplifier to said rectifying electrodes, an output circuit including one of said rectifying electrodes and said third electrode, a conductive circuit connecting said signal transferring means and said one rectifying electrode, and including a resistor, and means independent of said output circuit, and including said resistor, for supplying control energy derived from the action of said rectifying electrodes upon said signals, to said amplification control element.

12. In a signalling system, an amplifier including an amplification control element, a device comprising two rectifying electrodes and a third electrode, an input circuit including said two rectifying electrodes and means for transferring signals from said amplifier to said rectifying electrodes, an output circuit including one of said rectifying electrodes and said third electrode, a conductive circuit connecting said signal transferring means and said one rectifying electrode, and including a resistor, and means independent of said output circuit, and including said resistor, for supplying control energy derived from the action of said rectifying electrodes upon said signals, to said amplification control element, said one rectifying electrode being the cathode of said device, the other of said rectifying electrodes being a cold electrode adjacent the cathode, said third electrode being a plate arranged to receive electrons from the cathode.

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