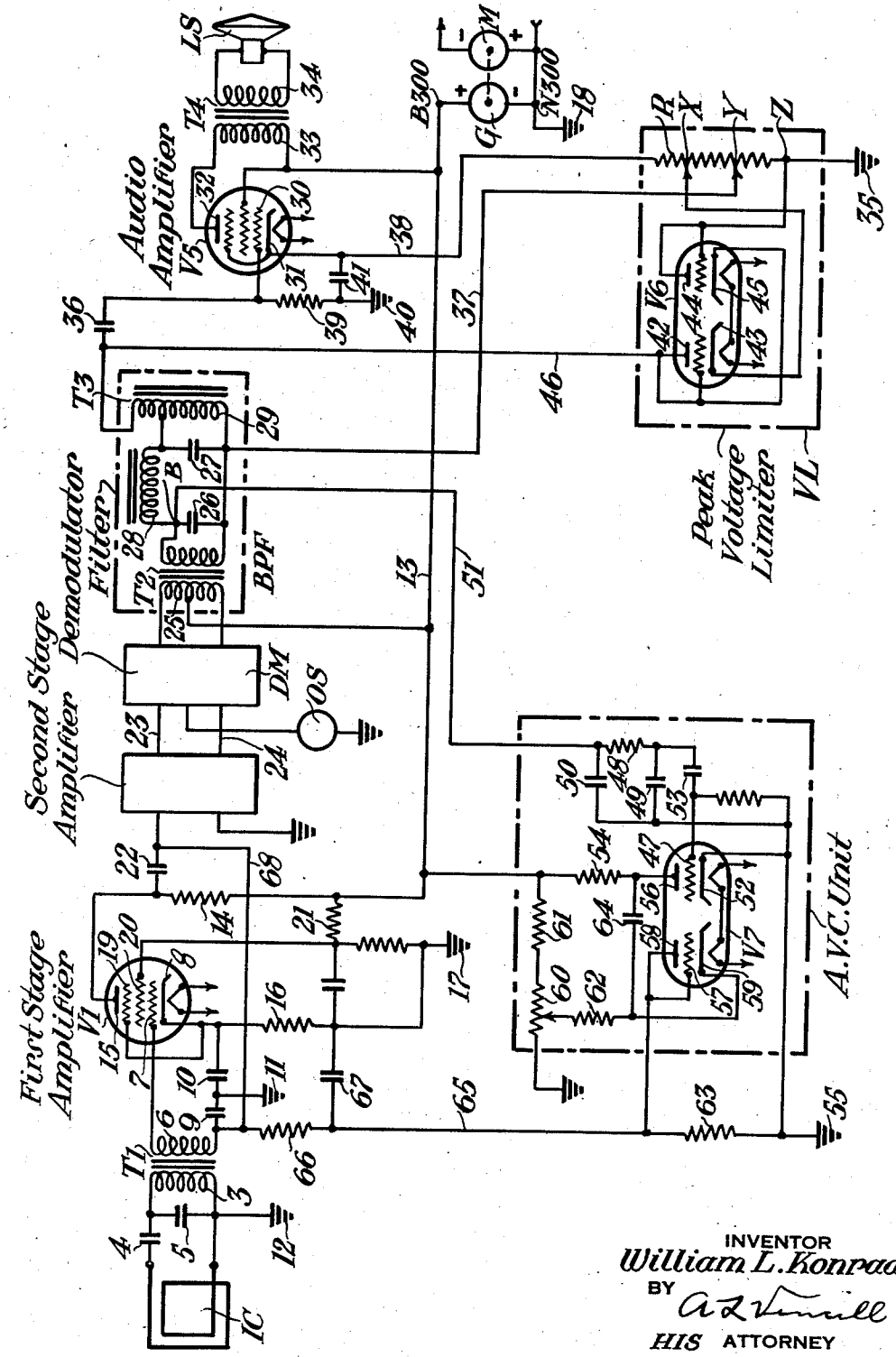
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APPARATUS FOR COMMUNICATION SYSTEMS

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APPARATUS FOR COMMUNICATION SYSTEMS

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My invention relates to apparatus for communication systems, and more particularly to receiving apparatus for railway train telephone systems.

Train telephone systems using the traffic rails in the transmitting channel require an electrical amplifier of relatively high gain between the train carried receiving inductor and the train carried signaling device such as, for example, a loud speaker. Preferably, the receiving apparatus of such a train communication system remains normally in the circuit ready to receive a message. This normal receiving condition results in amplification of minute earth currents, stray magnetic fields and similar random energy during non communication periods and noise may occur at the loud speaker. Also during communication periods amplification of the noise energy may impair the intelligibility of incoming messages. Furthermore, the energy level of the communication current at the receiving station may vary greatly due to the changing conditions of the transmitting channel through the rails and the changing distances between the station on a moving train and the remote station with which communication is being held, and as a consequence of such variations of the energy level, an adjustment of the receiving apparatus is required if uniform level of reproduction at the loud speaker is to be obtained.

In view of such circumstances, one object of my invention is the provision of communication receiving apparatus incorporating novel and improved means for limiting the amplitude of the voltage applied to a loud speaker.

Another object of my invention is the provision of receiving apparatus of the type here involved incorporating improved automatic volume control means.

Again, a more specific object of my invention is the provision of an improved peak voltage limiter and of a novel automatic volume control device for receiving apparatus of a railway train telephone system.

Other objects, features and advantages of my invention will appear as the specification progresses.

I shall describe one form of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

According to my invention I provide the final or audio stage amplifier of the receiving apparatus with a peak voltage limiter which is connected to the grid and plate circuits of the final stage tube in a novel manner to limit the peak voltage of the energy applied to the grid circuit of this tube and to control in turn the voltage applied to the loud speaker connected to the output side of this final stage amplifier. The peak voltage that can be applied to the final stage tube is preselected to be just above the desired communication current voltage peak so that the limiter does not affect communication current of normal value but does suppress strong momentary noise impulses and also communication current of high values. This peak voltage limiter preferably includes two asymmetric units and a bias voltage means. The bias voltage means includes a resistor interposed between the cathode of the final stage tube and the negative or ground terminal of the plate circuit current source, such resistor being provided with intermediate terminals from which different preselected voltages can be obtained due to the voltage drop through the resistor caused by the plate current flowing therethrough. One asymmetric unit is connected to the grid circuit of this final stage tube and to preselected ones of the intermediate terminals of the resistor and is positioned to pass the values of the positive half cycle of noise energy and of the communication current voltage greater than the bias voltage obtained from the terminals of the resistor preselected for this unit. The second asymmetric unit is connected to the grid circuit and to preselected other ones of the intermediate terminals of the resistor and is positioned to pass the values of the negative half cycle of noise energy and of the communication current voltage greater than the bias voltage obtained from the intermediate terminals of the resistor preselected for this second unit. Thus voltages greater than the desired peak voltage for the communication current are shunted through one or the other or both of the asymmetric units.

Also, according to my invention, I provide an automatic volume control means which preferably includes a twin triode electron tube. A voltage due to the communication current is taken from a preselected point in the receiving apparatus and fed through a resistance-capacitance filter to the control grid of one section of the twin triode tube to amplify such voltage. The other section of the twin triode tube is arranged as a rectifier to whose cathode a bias voltage is applied. The output of the amplifying section of the tube is fed to the rectifying section which becomes conductive when the amplified voltage overcomes the bias voltage. The energy thus rectified is applied to one or more of the earlier

stage tubes of the receiving apparatus as a negative bias voltage to control the amplification gain. A unit consisting of a condenser and a resistor is included in the circuit of the automatic volume control means to form a time delay device which maintains the control voltage between syllables and words of the received communication current.

For a better understanding of the invention, reference may be had to the accompanying drawing which is a diagrammatic view showing one form of apparatus embodying my invention when used with receiving apparatus for a railway train communication system using a suppressed carrier single side band telephone current. It is to be understood, however, that the invention is not limited to railway train communication systems and this one application serves to illustrate the many places where such apparatus is useful.

Referring to the drawing, the receiving apparatus includes a receiving inductor, two stages of intermediate frequency amplification, a demodulator, a filter, one stage of audio frequency amplification and a loud speaker. The reference character IC indicates a receiving inductor for picking up energy due to current sent out from a remote station, not shown. In railway train communication systems of the type referred to hereinbefore, the receiving inductor IC would be mounted on a train in inductive relation to the rails, the rails being included in a transmitting circuit to which current is supplied at the remote station.

The first stage of amplification includes an electron tube V1 which may be any one of the several well known types and is shown as an indirectly heated pentode whose filament is constantly heated in the usual manner. Receiving inductor IC is coupled to the control grid circuit of tube V1 through a transformer T1. Specifically, inductor IC is connected to primary winding 3 of transformer T1 through a condenser 4, a condenser 5 is connected across primary winding 3, and secondary winding 6 of transformer T1 is connected across control grid 7 and cathode 8 of tube V1 through two condensers 9 and 10 in series. Preferably, the junction terminal of condensers 9 and 10 is connected to a ground electrode 11 and one terminal of primary winding 3 of transformer T1 is connected to a ground electrode 12. Direct current of proper voltage for the plate circuit of tube V1, as well as for other electron tubes of the apparatus to be referred to later, is supplied from a generator G. When the receiving apparatus is mounted on a train, generator G may be driven by a motor M energized from the usual train lighting source. The plate circuit for tube V1 can be traced from positive terminal B300 of generator G through wire 13, resistor 14, plate 15 and intervening tube space to cathode 8 of tube V1, resistor 16 and ground electrodes 17 and 18 to negative terminal N300 of generator G. A first auxiliary grid 19 of tube V1 is connected to cathode 8 and the other auxiliary grid 20 of the tube is supplied with positive voltage from generator G through resistor 21.

It is clear that the electromotive force picked up by inductor IC due to the communication current, is amplified in the plate circuit of tube V1 in the well-known manner. As an aid to the understanding of the operation of the apparatus, I shall assume that the communication current is a suppressed carrier single side band telephone current whose carrier frequency is of the order of 5700 cycles per second, the voice frequency band for modulating the carrier is of 400 to 2500 cycles per second, and the upper side band of 6100 to 8200 cycles per second is the side band selected for transmission. Thus the plate circuit current of tube V1 has a component corresponding to such communication current received through inductor IC.

The second stage of amplification includes an electron tube whose control grid circuit is coupled to the plate circuit of the first stage tube V1 through a condenser 22. This second stage of amplification is shown conventionally for the sake of simplicity because it can be of any well-known construction and may be substantially a duplication of the first stage, and a description of the second stage is not required for a full understanding of my invention. It is sufficient to point out that the communication current component passed from the plate circuit of tube V1 to the control grid circuit of the second stage is amplified in the usual manner and is supplied from the output of the second stage amplifier to the input side of a demodulator DM through wires 23 and 24.

Demodulator DM may be any one of several well-known forms and is shown conventionally in order to not unduly complicate the drawing because its specific construction forms no part of my invention. For example, this demodulator may be of the balanced type covered by Letters Patent of the United States No. 2,129,313, granted September 6, 1938 to L. D. Whitelock, for Apparatus for electric signaling systems. It is sufficient for the present application to point out that in demodulator DM a carrier from a local oscillator OS is mixed with the side band telephone current supplied through the second stage amplifier, and the carrier is suppressed at a push-pull arrangement of primary winding 25 of a transformer T2 included in the output circuit of the demodulator. Thus one product of demodulation to appear in primary winding 25 is the voice frequencies of the communication current received by inductor IC.

Band pass filter BPF comprises transformer T2, condensers 26 and 27, inductance 28 and at least a portion of winding 29 of an auto transformer T3. This band pass filter is arranged in a well-known manner and is proportioned to pass the voice frequencies and to substantially eliminate the other products of demodulation so that the voltages appearing across winding 29 of transformer T3 are those of the voice frequencies, or at least of a frequency within the selected voice frequency range.

The final and audio amplification stage of the receiving apparatus includes an indirectly heated pentode V5, whose filament is constantly heated and whose control grid 30 and cathode 31 are connected to winding 29 of the band pass filter through a grid circuit to appear shortly. Plate voltage for plate 32 of tube V5 is supplied from generator G through primary winding 33 of an output transformer T4 to whose secondary winding 34 a loud speaker LS is connected. It follows that energy passed by the band pass filter BPF is amplified by tube V5 and is applied to the loud speaker.

According to my invention, a peak voltage limiter VL is connected to the final stage amplifier to limit the peak voltage applied to the control grid of the tube of the final stage and in turn to control the peak voltage that can be applied to

the loud speaker LS. This voltage limiter VL may take different forms, and preferably includes an electron tube V6 and a resistor R. Resistor R is interposed in the lead between cathode 31 of tube V5 and the negative terminal N300 of generator G, the connection being completed through ground electrodes 35 and 18. Resistor R is thus interposed in the plate circuit of tube V5 and a voltage drop is created across the resistor due to the plate current, the value of such voltage drop being predetermined according to the value of resistor R and to the value of the plate current. Resistor R is provided with a negative terminal Z and two adjustable intermediate or mid terminals X and Y. Thus the voltage of terminals X and Y with respect to the negative terminal Z and with respect to each other can be preselected by their positions. For example, terminal Y may be four volts positive with respect to terminal Z and terminal X may be four volts positive with respect to terminal Y, and in turn eight volts positive with respect to terminal Z. Electron tube V6 is preferably a twin triode, that is a tube containing two triodes in a common envelope. Each triode of tube V6 is preferably converted into an asymmetric unit or one-way thermionic valve connecting the grid and plate together. I have found that a twin triode tube thus arranged gives more satisfactory operation because of the lower tube impedance than a twin diode or two separate diodes. My invention is not limited, however, to a twin triode arranged to form two one-way thermionic valves in the manner here used and other forms of tubes can be used. The filaments of tube V6 are constantly heated and for convenience I shall refer to the left-hand side of the tube as viewed in the drawing as section 1 of the tube and to the right-hand side of the tube as section 2.

Each section of the tube V6 is connected across the grid circuit of tube V5 through a portion of resistor R. Specifically, the control grid circuit for tube V5 can be traced from control grid 30, through condenser 36, winding 29 of transformer T3, wire 37, terminal Y of resistor R, and top portion of resistor R and wire 38 to cathode 31, a resistor 39 being connected between control grid 30 and a ground electrode 40 and a condenser 41 being connected between cathode 31 and ground electrode 40. Section 1 of tube V6 is connected to this grid circuit by having its plate or anode 42 connected to the top terminal of winding 29 by wire 46 and its cathode 43 connected to the lower terminal of winding 29 through terminal X of resistor R, the portion of resistor R to terminal Y and wire 37. It is clear that this first section is provided with a bias voltage equal to the voltage drop between terminals X and Y, and its cathode 43 is positive in potential with respect to its anode 42. Section 2 of tube V6 is connected to the grid circuit of tube V5 by having its anode 44 connected to the lower terminal of winding 29 through negative terminal Z of resistor R, that portion of resistor R to terminal Y and wire 37, and its cathode 45 connected to the top terminal of winding 29 through wire 46. Thus this second section is provided with a bias voltage equal to the voltage drop between terminals Y and Z of resistor R, the cathode 45 being positive in potential with respect to anode 44. The positions of terminals X and Y are preselected so that the voltages of these terminals are such that each section of tube V6 is provided with a bias voltage that is only slightly greater than the desired peak voltage of the communication current appearing in winding 29 and applied to tube V5. For example, each such bias voltage may be of the order of four volts.

It can be seen therefore that any electromotive force created across winding 29 of transformer T3 to be applied to the control grid of tube V5, would be shunted through one or the other of the sections of tube V6 of the voltage limiter but for the bias voltages applied to the sections. For example, when the electromotive force appearing in winding 29 causes the top terminal of the winding to be positive, section 1 of tube V6 tends to conduct the current but current flow is blocked by the bias voltage derived from terminal X of resistor R. This section becomes conductive however as soon as the electromotive force is greater than the bias voltage. Similarly, when the electromotive force of winding 29 causes its lower terminal to be positive the section 2 of tube V6 tends to conduct the current but flow of current is blocked by the bias voltage derived from terminal Y, this section becoming conductive when the electromotive force is of a value sufficient to overcome the bias voltage. Consequently, the values of the positive half cycles of the communication current higher than a desired peak value are shunted from the grid circuit of tube V5 by one asymmetric unit or one-way thermionic valve of the voltage limiter, and the values of the negative half cycles of such current higher than the desired peak value are shunted by the other asymmetric unit or one-way thermionic valve of the voltage limiter. Likewise, the values of an impulse of noise energy higher than the predetermined value appearing across winding 29 are shunted by the voltage limiter and these higher voltages of the noise energy are prevented from appearing at the loud speaker. Hence noise energy occurring during non-communicative periods is attenuated so as to not be annoying. It is to be observed that noise energy of sufficient strength to be shunted by the voltage limiter occurring during communication periods may cause some shunting of the desired communication current voltage. However, in systems of the type here contemplated, the noise impulses are ordinarily of short duration as compared to the desired communication current voltages, and the desired communication voltage is not affected long enough to impair its intelligibility while the noise is greatly attenuated. It is also to be observed that the component of the plate current of tube V5 corresponding to the communication current is by-passed by condenser 41, leaving the bias voltages for the voltage limiter to be of substantially the same value during communication periods as is provided during non communication periods.

An automatic volume control unit AVC is provided for the receiving apparatus. This unit AVC includes a twin triode tube V7, whose filaments are heated in the usual manner. Voltage from a preselected terminal B of filter BPF is applied to control grid 47 and cathode 52 of the right-hand triode of tube V7 as viewed in the drawing, the circuit connection including wire 51, a resistance-capacitance filter comprising resistor 48 and condensers 49 and 50, and a condenser 53. Plate voltage is supplied to plate 56 of the right-hand triode of tube V7 from generator G through wire 13 and resistor 54, the plate circuit being completed from cathode 52 through ground electrodes 55 and 18 to negative terminal

N300 of generator G. Thus the communication current voltage appearing at terminal B of the band pass filter is amplified by the right-hand triode of tube V7 of the automatic volume control unit.

The left-hand triode of tube V7 is converted into a diode rectifier by its control grid 57 being connected to plate 58. A bias voltage is applied to cathode 59 of the diode rectifier through resistors 60 and 61 connected across generator G and a resistor 62 connected between the cathode and a preselected mid terminal of resistor 60. Plate 58 of the diode rectifier is further connected to a ground electrode 55 through resistor 63. Thus, the cathode 59 of the diode rectifier is made positive in potential with respect to the plate 58 by a voltage preselected by the connection to resistor 60. The amplified output of the triode of tube V7 is applied to the diode section of the tube through condenser 64 connected between plate 56 of the triode and cathode 59 of the diode. Consequently, when the voltage from terminal B after amplification at the triode of tube V7 is greater than the bias voltage of the diode section of the tube, the voltage is rectified by the diode and current flows in resistor 63, the top terminal as viewed in the drawing of resistor 63 being negative with respect to ground electrode 55.

This voltage created across resistor 63 is supplied to the control grid 7 of the first stage tube V1 through a connection including wire 65 and resistor 66. Thus when the communication current is of a large amplitude and a relatively large voltage appears at terminal B of the band pass filter, the first stage tube V1 is provided with an additional negative bias voltage to reduce the amplification gain. If desired, this automatic volume control voltage can be applied to the tube of the second stage of the amplifier by a connection including wire 68 extending from resistor 66 to the grid circuit of the second stage tube.

A condenser 67 is connected in shunt with resistor 63 to form a time delay device, condenser 67 being charged by the rectified voltage and such charge serving to maintain the automatic volume control voltage between syllables and words of the received communication current.

It is to be seen from the foregoing description that I have provided the receiving apparatus with a peak voltage limiter which shunts communication current and noise voltages above a predetermined value, with the result the loud speaker is comparatively quiet during noncommunication periods and during communication periods excessive loudness of the message is avoided and noise is greatly attenuated without affecting the intelligibility of the message. Also the automatic volume control unit permits adjustment of the receiving apparatus for a relatively low energy level of communication current without excessive loudness when the communication current becomes of relatively high amplitude.

Although I have herein shown and described only one form of apparatus for communication systems embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In communication receiving apparatus including an electron tube amplifier provided with a grid circuit having a winding through which a communication electromotive force is applied and with a plate circuit supplied with current from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed between the cathode of said tube and the negative terminal of said direct current source and having a first intermediate terminal connected to one terminal of said grid circuit winding to include the full resistor in said plate circuit and a portion in said grid circuit; a voltage limiter including a first and second one-way thermionic valve arranged with the anode of the first valve and the cathode of the second valve connected to the other terminal of said grid circuit winding, the anode of the second valve connected to the negative terminal of said direct current source and the cathode of the first valve connected to a second intermediate terminal of said resistor; and said first and second terminals positioned on said resistor to bias said first valve by the voltage drop derived between said second and first terminals and to bias said second valve by the voltage drop derived between said first terminal and said negative terminal.

2. In communication receiving apparatus including an electron tube amplified provided with a grid circuit having a winding through which a communication electromotive force is applied and with a plate circuit supplied with current from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed between the cathode of said tube and the negative terminal of said direct current source and provided with a first intermediate terminal to which one terminal of said grid circuit winding is connected to include the full resistor in the plate circuit and a portion in said grid circuit; and a voltage limiter including a first and a second rectifying device each having one of its terminals connected to the other terminal of said grid circuit winding, the other terminal of said first device connected to the negative terminal of said direct current source, and the other terminal of said second device connected to a second intermediate terminal of said resistor more remote from said negative terminal than said first intermediate terminal, and said first and second rectifying devices poled to pass current in opposite directions.

3. In communication receiving apparatus having an audio stage amplifier including an electron tube provided with a grid circuit including a winding through which communication electromotive force is received and with a plate circuit supplied with current from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed in the plate circuit between the cathode of said tube and the negative terminal of said direct current source, said resistor having a first intermediate terminal to which one terminal of said grid circuit winding is connected, a first rectifying device having one terminal connected to the other terminal of said grid circuit winding and its other terminal connected to a second intermediate terminal of said resistor, a second rectifying device having one terminal connected to the negative end of said resistor and its other terminal connected to said other terminal of said grid circuit winding, and said first and second intermediate terminals preselected as to their positions on said resistor to bias said first device

due to the voltage drop created in the resistor between said second and first terminals and to bias said second device due to the voltage drop created in the resistor between said first terminal and said negative end, and said first and second rectifying devices disposed to pass current in opposite directions.

4. In communication receiving apparatus having an audio stage amplifier including an electron tube provided with a grid circuit to which a communication electromotive force is applied and with a plate circuit supplied with current from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed in said plate circuit between the cathode of said tube and the negative terminal of said direct current source to provide a voltage drop due to the plate current flowing through the resistor, said resistor having a first and a second intermediate terminal arranged in the order named from the negative end of the resistor, said grid circuit connected to said first intermediate terminal, a first one-way thermionic valve connected across said grid circuit with its cathode connected to said second intermediate terminal, and a second one-way thermionic valve connected across said grid circuit with its anode connected to the negative end of said resistor.

5. In communication receiving apparatus having an amplifying stage including an electron tube provided with a grid circuit to which a communication electromotive force is applied and a plate circuit supplied from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed in said plate circuit between the cathode of said tube and said direct current source; said resistor provided with a first, a second and a third terminal disposed in the order named from the negative end of the resistor and spaced for the second terminal to have a preselected positive voltage with respect to the first terminal and the third terminal to have the same preselected positive voltage with respect to the second terminal due to the plate circuit current flowing through the resistor; said grid circuit connected to said second terminal to connect that circuit to the cathode of the tube, a first one-way thermionic valve connected across said grid circuit with its cathode connected to said third terminal to shunt the values of the positive half cycle of current applied to said grid circuit greater than said preselected voltage, and a second one-way thermionic valve connected across said grid circuit with its anode connected to said first terminal to shunt the values of the negative half cycle of current applied to said grid circuit greater than said preselected voltage.

6. In communication receiving apparatus having an amplifying stage including an electron tube provided with a grid circuit to which a communication electromotive force is applied and a plate circuit supplied from a direct current source and coupled to a loud speaker, the combination comprising, a resistor interposed in said plate circuit between the cathode of said tube and said direct current source; said resistor provided with a first, a second and a third terminal disposed in the order named from the negative end of the resistor and spaced for the second terminal to have a preselected positive voltage with respect to the first terminal and the third terminal to have the same preselected positive voltage with respect to the second terminal due to the plate circuit current flowing through the resistor; said grid circuit connected to said second terminal to connect that circuit to the cathode of the tube, a first one-way thermionic valve connected across said grid circuit with its cathode connected to said third terminal to shunt the values of the positive half cycle of current applied to said grid circuit greater than said preselected voltage, a second one-way thermionic valve connected across said grid circuit with its anode connected to said first terminal to shunt the values of the negative half cycle of current applied to said grid circuit greater than said preselected voltage, and a condenser connected between the cathode of said amplifier tube and the negative terminal of said direct current source to bypass the communication current component of the plate circuit current around said resistor.

7. In combination, an amplifying electron tube having a plate circuit supplied with current from a source of direct current and including an output winding; a resistor interposed in said plate circuit between the cathode of said tube and the negative terminal of said direct current source and provided with a first, a second and a third terminal disposed in the order named from the negative end of the resistor and spaced for the plate circuit current to create the same preselected voltage drop between the third and second terminals and between the second and first terminals; a grid circuit including a coupling element having one terminal connected to the control grid of said tube and its other terminal connected to said second resistor terminal; and a twin triode having the grid of each of its sections connected to the anode of that section for each section to serve as an asymmetric unit, said triode having the anode of a first one of its sections and the cathode of a second one of its sections connected to said one terminal of said coupling element, the anode of its second section connected to said first resistor terminal and the cathode of its first section connected to said third resistor terminal to limit the voltage applied to the grid of said tube through said coupling element to a value not greater than said preselected voltage drop.

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