

March 14, 1933.

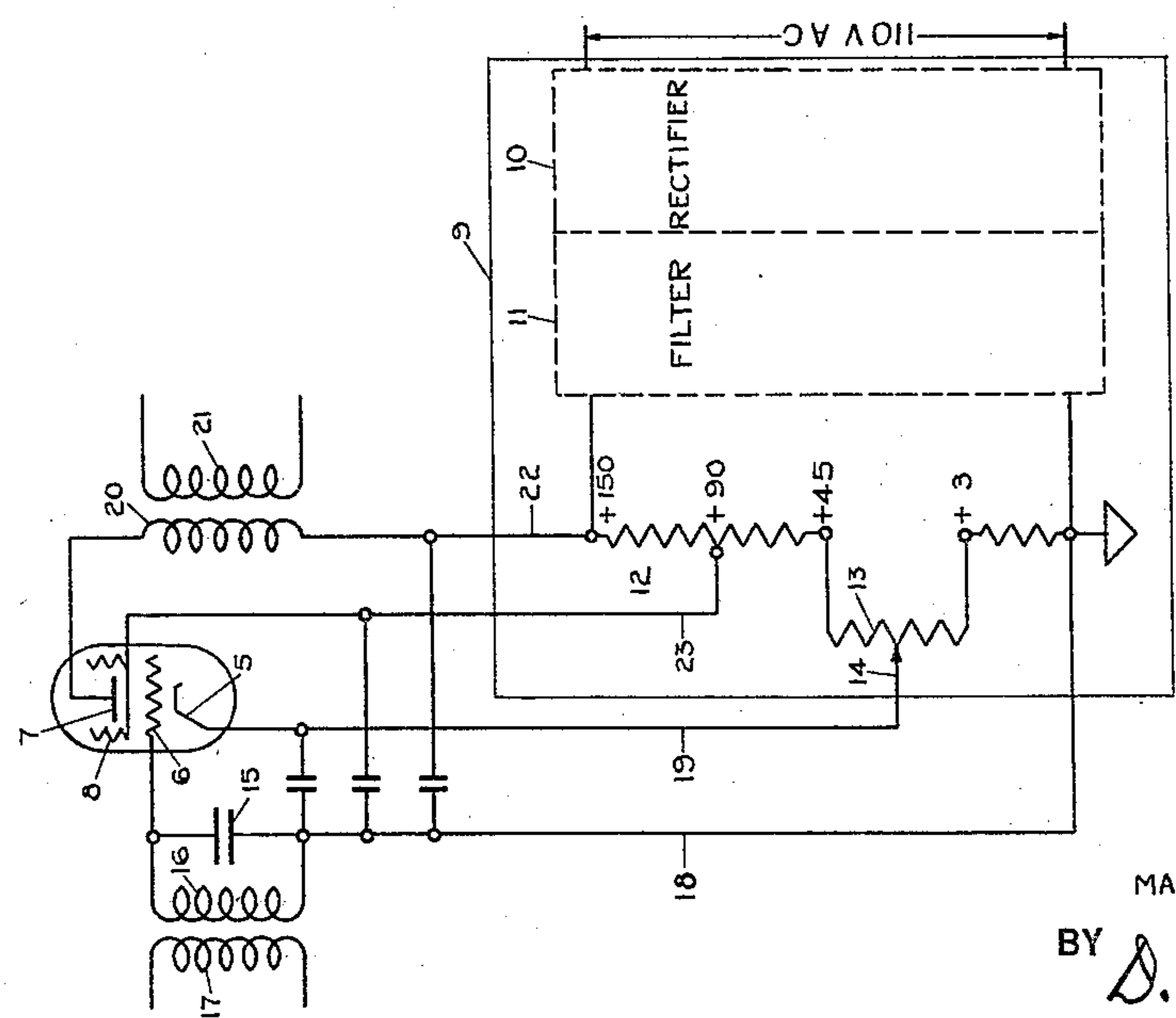
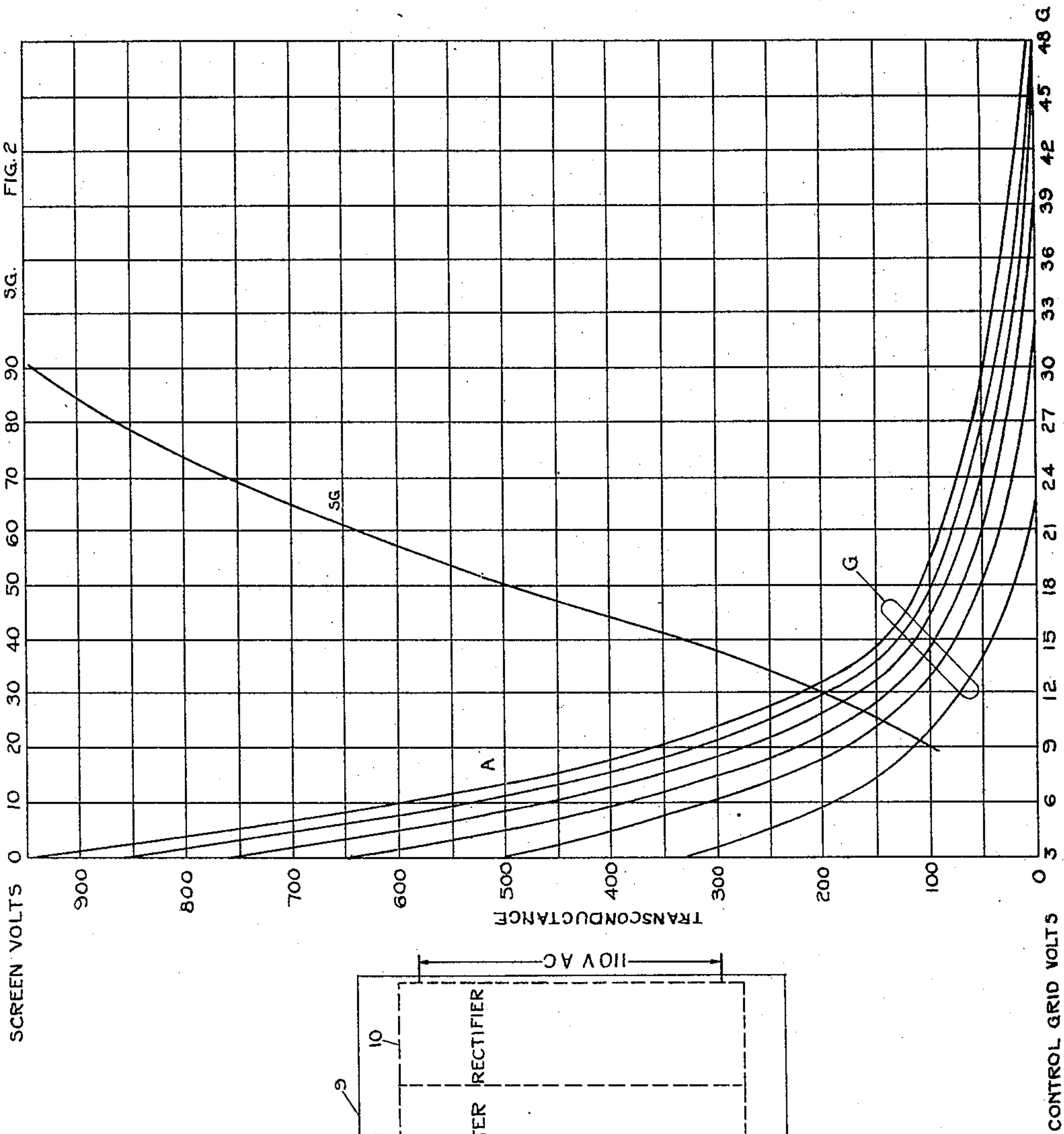
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1,901,350

RADIO SIGNALING SYSTEM

Filed Feb. 20, 1931

2 Sheets-Sheet 1



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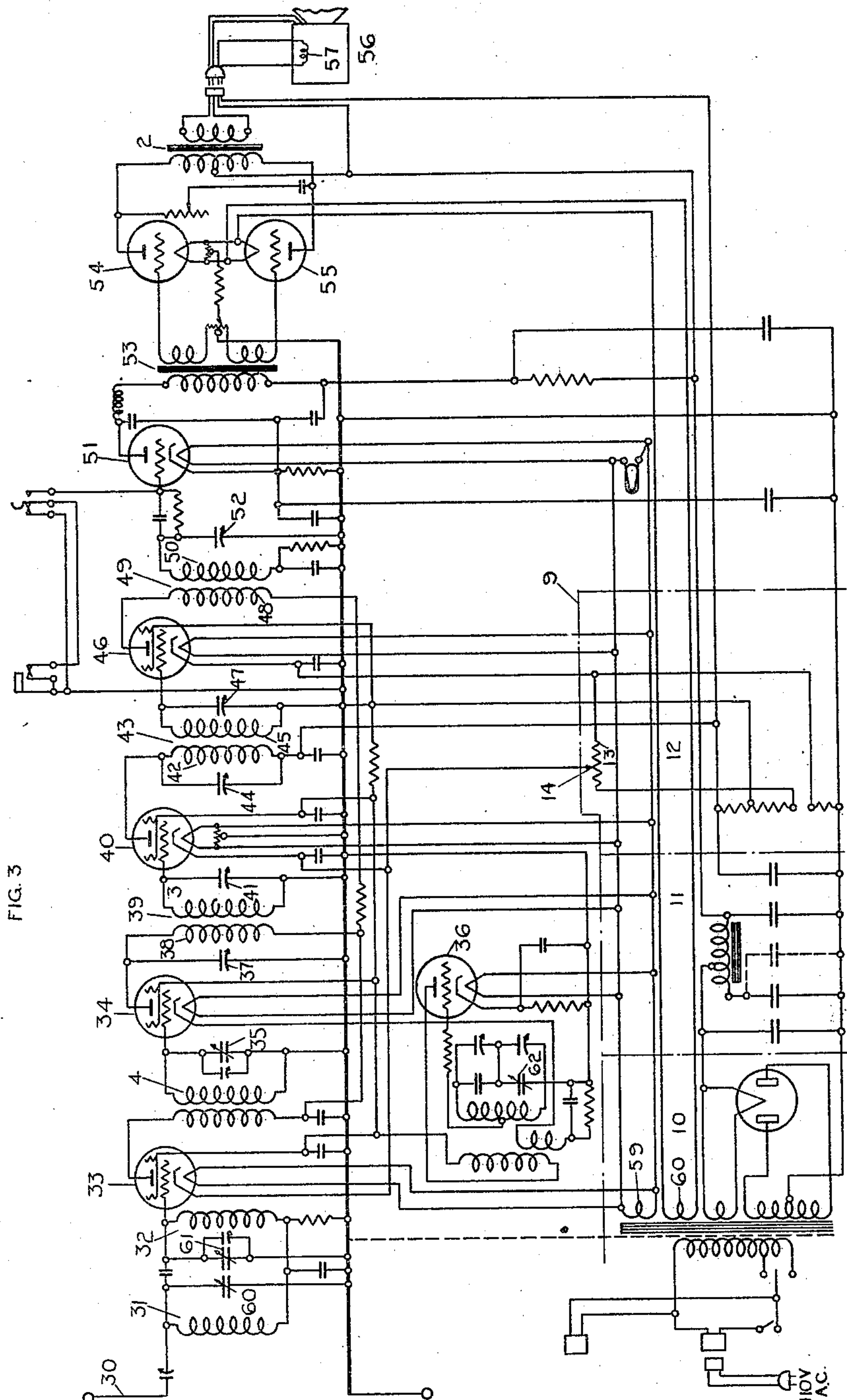


FIG. 3

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RADIO SIGNALING SYSTEM

Application filed February 20, 1931. Serial No. 517,190.

This invention relates to signaling systems and more particularly to radio receiving systems.

In certain types of radio receivers now in use, it is customary to link the antenna to the first stage of the amplifier by a circuit network including a range control device whereby the amplifier may be operated to receive both weak and strong signals without overloading the vacuum tube or tubes of the amplifier which overload would result in distortion of the amplified signal. In the usual form of a range control device, an adjustable switching mechanism is incorporated for adjusting the network to pass weak or strong signals to the amplifier as desired. However, in modern radio receivers, it is essential that the number of required adjustments by the user should be reduced to a minimum not only because of complication in the operation of the radio receiver, but because such adjustable devices are sometimes the cause of failure in the radio receiver. In order to obviate the need of such a volume control device, it is proposed to use in each of certain stages of the amplifier, an exponential tetrode tube, that is, a vacuum tube having four elements which are of such dimensions and are so arranged with respect to each other and with respect to the envelop in which the elements are contained that the tube, when energized by proper voltages applied to its elements, has an exponential characteristic. In other words, the transconductance of the vacuum tube varies with respect to the voltage applied to its control grid in accordance with an exponential function. A vacuum tube having such characteristics efficiently amplifies weak signals and at the same time amplifies strong signals without the danger of overload and the consequent distortion. Where such exponential vacuum tubes are used in a multi-stage amplifier, the problem of supplying suitable voltages to the several stages of the amplifier becomes a difficult one unless the size and range of the power supply device and the hum-eliminating or filtering network is unduly increased at a substantial rise in cost. In such a receiver, it is also highly desirable to provide a volume control

arrangement wherein the rate of change in volume of the amplified signal is proportional to the angular rotation of an adjustable element of a volume control device which arrangement will operate efficiently without undue complication of the power supply unit.

In accordance with the present invention, a radio receiving system is provided in which certain of the amplifying stages thereof include vacuum tubes having exponential characteristics, which tubes may be energized from an economical power supply device and in which system the amplified signal may be uniformly varied without complicating the circuit networks and without complicating the mechanical structure.

These and other novel features of the invention will appear from the detailed description and the appended claims.

For a clearer understanding of the invention, reference is made to the drawings in which Fig. 1 is a diagrammatic showing of a single amplifying stage suitable for use in various types of radio receivers; Fig. 2 is a chart useful in explaining the operation of the amplifier; and Fig. 3 is a diagrammatic showing of the invention applied to one of several suitable types of radio receivers herein diagrammatically represented as being of the superheterodyne type.

The single amplifying stage shown in Fig. 1 includes a tetrode or four-element vacuum tube having a cathode 5, a control grid 6, an anode 7, and a screen 8 for shielding the grid from the anode. This vacuum tube also includes suitable means (not shown) for heating the cathode. The several elements of the tetrode tube are so proportioned and are so spaced with respect to each other that this tube has an exponential characteristic, that is, its transconductance varies as an exponential function with respect to the voltage applied to the control grid 6. This characteristic of the tetrode tube is shown by the series of curves G in the chart of Fig. 2.

The voltages for the several elements of the tetrode tube are applied from a power device generally designated 9 which includes a rectifier 10 for translating 110-volt alternating current into pulsating current, the pulsa-

tions of which are smoothed out by a suitable filter unit 11. Across the output of the filter, there is connected a voltage divider 12 including resistance units from which certain fixed taps lead to the several electrodes of the tetrode tube. One of these resistance units designated 13, however, is engaged by a variable wiper 14 leading to the cathode 5, while the control grid 6 is connected to the ground terminal of the output of the filter. In one suitable arrangement, the maximum voltage delivered by the filter is 150 volts and from this 150-volt tap, a conductor leads to the anode 7, and at the point on the voltage divider where the voltage is 90 volts, a tap leads to the screen 8. However, the wiper 14 which is connected to the cathode, is adjustable over that portion 13 of the voltage divider between the points where the voltage is plus 3 and plus 45 volts. The values given above are merely by way of an example and are not to be taken as limiting the invention.

The input circuit of the tetrode tube, including the control grid 6 of the cathode 5, is tuned by a capacitor 15 and a secondary winding 16 of a transformer, the primary 17 of which is connected to a source of signals to be amplified. One terminal of this tuned circuit is connected directly to the control grid 6 while the other terminal thereof is connected by the conductor 18 through the portion of the resistor between the ground connection and the wiper 14 and thence over conductor 19 to the cathode 5. This last-mentioned portion of the resistor 13 serves to maintain the control grid at the proper bias with respect to the cathode. The output circuit of the amplifier extends from the anode 7, primary winding 20 of an output transformer (the secondary winding 21 of which may lead to a succeeding amplifier), conductor 22, the upper portion of the resistor as far as the variable wiper 14 and thence over conductor 19 to the cathode. The screen 8 is connected by the conductor 23 to the 90-volt tap of the voltage divider so that there is always the same fixed difference of potential between the screen 8 and the anode 7.

When it is desired to change the transconductance of the tetrode tube in this stage, the wiper 14 is adjusted to engage different turns of the resistance unit 13. When the wiper is moved downward, the difference in potential between the cathode and the grid 6 is diminished while the difference in potential between the cathode and the screen 8 is increased; whereas an upward movement of this wiper reverses this condition. The resultant effect of varying the adjustment of the wiper 14 is shown in Fig. 2 wherein a series of exponential curves G represents the effect of the change in the difference in potential between the cathode and grid, while the relatively straight line SG indicates the effect

of the change in the difference of potential between the cathode and the screen.

While the amplifying stage just described may be used in any one of several different types of radio receiver, in Fig. 3 it is shown incorporated in a radio receiver of the super-heterodyne type. In this radio receiving system, 30 designates an antenna which is linked by means of the coupling network including the tuned circuits 31 and 32 to an exponential tetrode tube 33 in which the cathode, control grid screen and anode are energized from the power supply device 9 including the rectifier 10, the filter 11 and the voltage divider 12. The output of the first radio frequency stage including the tetrode tube 33 is linked to the input circuit of a mixer or first detector including a tetrode tube 34 which need not have exponential characteristics. The input circuit of this mixer is tuned by an inductance unit 4 and a capacitor 35. The input of the mixer is also coupled to a local oscillator 36 so that the incoming signal frequency and the frequency of the local oscillator may be combined to give, in the output circuit of the mixer, a resultant frequency, herein referred to as an intermediate frequency. The output circuit of the mixer is tuned by a capacitor 37 and the primary winding 38 of a transformer 39. The secondary winding 3 of this transformer, which is loosely coupled to the primary winding, is connected in the input circuit of a first intermediate frequency amplifier stage including the exponential tetrode tube 40, which input circuit is tuned by the secondary winding 3 and capacitor 41. The output of this first intermediate frequency stage is tuned by means of a primary winding 42 of a radio frequency transformer 43 and by the capacitor 44, and the secondary winding 45 of this transformer, which is loosely coupled to the primary winding thereof, is included in the input circuit of a second intermediate frequency amplifier stage including the exponential tetrode tube 46. This input circuit is tuned by a capacitor 47 connected in multiple of the secondary winding 45. The output circuit of this second intermediate amplifier stage includes the primary winding 48 of a radio frequency transformer 49, the secondary winding 50 of which, loosely coupled to the mentioned primary winding, is included in the input circuit of a detector including the triode vacuum tube 51. The input circuit of this detector is tuned by the capacitor 52 connected in multiple with the winding 50. The output of the detector is coupled by the audio transformer 53 to an audio amplifier provided with two triode vacuum tubes 54 and 55 connected in push-pull arrangement; while the audio transformer 2 links the audio amplifier to a loud speaker 56. This loud speaker is preferably of the moving coil type in which the field winding 57 thereof is

utilized as one of the elements of the filter 11. It will be understood that the filaments or heaters of the tetrodes 33, 34, 40, 46, 51 and 36 are energized in multiple from the secondary winding 59 of the power transformer, and the filaments of the tubes, 54 and 53 are energized in multiple from the secondary winding 60 of the power transformer. It will be noted that the wiper 14 is connected over the conductor 13 to the cathodes of the exponential tetrode tubes 33 and 40 so that the volume control knob, which actuates the wiper 14, is effective to increase or diminish the amplification effected through these tubes and thereby increase or diminish the volume of signals reproduced by the loud speaker 56. For ease in tuning the rotors of the capacitors 60, 61, 62 and 35 are simultaneously adjusted by a single control.

It will be understood that the present disclosure is given by way of an example and should not be construed in a limiting sense, since there may be many modifications and variations of the invention all within the scope of the following claims.

What I claim is:

1. The method of adjusting the amplification of an amplifier including a vacuum tube having cathode, control grid, and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation to the voltage applied to said control grid which comprises simultaneously varying the voltages applied to said control grid and said screen in such a manner that the transconductance of the vacuum tube varies substantially as an exponential function.

2. The method of adjusting the amplification of an amplifier including a vacuum tube having cathode, control grid, and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation to the voltage applied to said control grid which comprises varying simultaneously the difference in potential between said grid and said cathode and also the difference in potential between said cathode and said screen in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and of a substantially exponential function.

3. The method of adjusting the amplification of an amplifier including a vacuum tube having cathode, control grid, and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation to the voltage ap-

plied to said control grid which comprises varying simultaneously the difference in potential between said grid and said cathode and also the difference in potential between said cathode and said screen while maintaining a fixed difference in potential between said screen and said anode in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and of a substantially exponential function.

4. The method of varying the amplification of an amplifier including a vacuum tube having cathode, control grid and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation with the voltage applied to said grid which comprises normally maintaining said control grid at ground potential and varying the difference in potential between said grid and said cathode in such a manner that the transconductance of the vacuum tube varies substantially as an exponential function.

5. The method of varying the amplification of an amplifier including a vacuum tube having cathode, control grid and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation with the voltage applied to said grid which comprises normally maintaining said control grid at ground potential and varying the difference in potential between said grid and said cathode, and simultaneously varying the difference in potential between said cathode and said screen in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

6. The method of varying the amplification of an amplifier including a vacuum tube having cathode, control grid and anode elements and a screen shielding said control grid from said anode, said vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation with the voltage applied to said grid which comprises normally maintaining said control grid at ground potential and varying the difference in potential between said grid and said cathode, and simultaneously varying the difference in potential between said cathode and said screen while maintaining a uniform difference in potential between said anode and said screen in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

7. The method of varying the amplifica-

tion of a multi-stage amplifier, each stage including a vacuum tube having cathode, control grid and anode elements, and a screen shielding said grid element from said anode element, each vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation to said grid, which comprises simultaneously varying the difference in potential between the grid and cathode of the vacuum tube in each of certain of said stages in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

8. The method of varying the amplification of a multi-stage amplifier, each stage including a vacuum tube having cathode, control grid and anode elements, and a screen shielding said grid element from said anode element, each vacuum tube having its parts so proportioned and arranged and being operated so that the anode current varies in exponential relation to said grid, which comprises simultaneously varying the difference in potential between the grid and cathode and also the difference in potential between said cathode and said screen of the vacuum tube in each of certain of said stages in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

9. An amplifier including a tetrode tube provided with a cathode, a control-grid, an anode and a screen shielding said grid from said anode, said tetrode tube having its elements so proportioned and arranged that its transconductance varies in exponential relation to the voltage applied to said grid, a power supply device connected to said elements of said tetrode tube and means for simultaneously varying the voltage applied to said screen and to said grid in such a manner that the transconductance of the vacuum tube varies substantially as an exponential function.

10. An amplifier including a tetrode tube provided with a cathode, a control-grid, an anode and a screen shielding said grid from said anode, said tetrode tube having its elements so proportioned and arranged that its transconductance varies in exponential relation to the voltage applied to said grid, a power supply device connected to said elements of said tetrode tube, and means for simultaneously varying the difference in potential between said cathode and said screen and also the difference in potential between said cathode and said grid in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

11. An amplifier including a tetrode tube

provided with a cathode, a control-grid, an anode and a screen shielding said grid from said anode, said tetrode tube having its elements so proportioned and arranged that its transconductance varies in exponential relation to the voltage applied to said grid, a power supply device connected to the elements of said tetrode tube, and means for simultaneously varying the difference in potential between said cathode and said screen and also the difference in potential between said cathode and said grid while maintaining a fixed difference in potential between said screen and said anode in such a manner that the transconductance of the vacuum tube varies as the resultant of a substantially linear function and a substantially exponential function.

12. In a multi-stage amplifier, each stage including a tetrode tube provided with a cathode and a control-grid, an anode and a screen shielding said grid from said anode, each tetrode tube having its elements so proportioned and arranged that its transconductance varies in exponential relation to the voltage applied to said grid, and means for simultaneously varying the difference in potential between the cathode and screen and also the difference in potential between the cathode and grid of each of said tetrode tubes in such a manner that the transconductance of each vacuum tube varies substantially as the resultant of a substantially linear function and a substantially exponential function.

13. In a multi-stage amplifier, each stage including a tetrode tube provided with a cathode, a control-grid, an anode and a screen shielding said grid from said anode, each tetrode tube having its elements so proportioned and arranged that its transconductance varies in exponential relation to the voltage applied to said grid, and means for simultaneously varying the difference in potential between the cathode and screen and also the difference in potential between the cathode and grid of each of said tetrode tubes, while maintaining a fixed difference in potential between the screen and the anode of each of said tetrode tubes in such a manner that the transconductance of each vacuum tube varies substantially as the resultant of a substantially linear function and a substantially exponential function.

In witness whereof, I hereunto subscribe my name this 18th day of February, A. D. 1931.

MAURICE L. LEVY.