

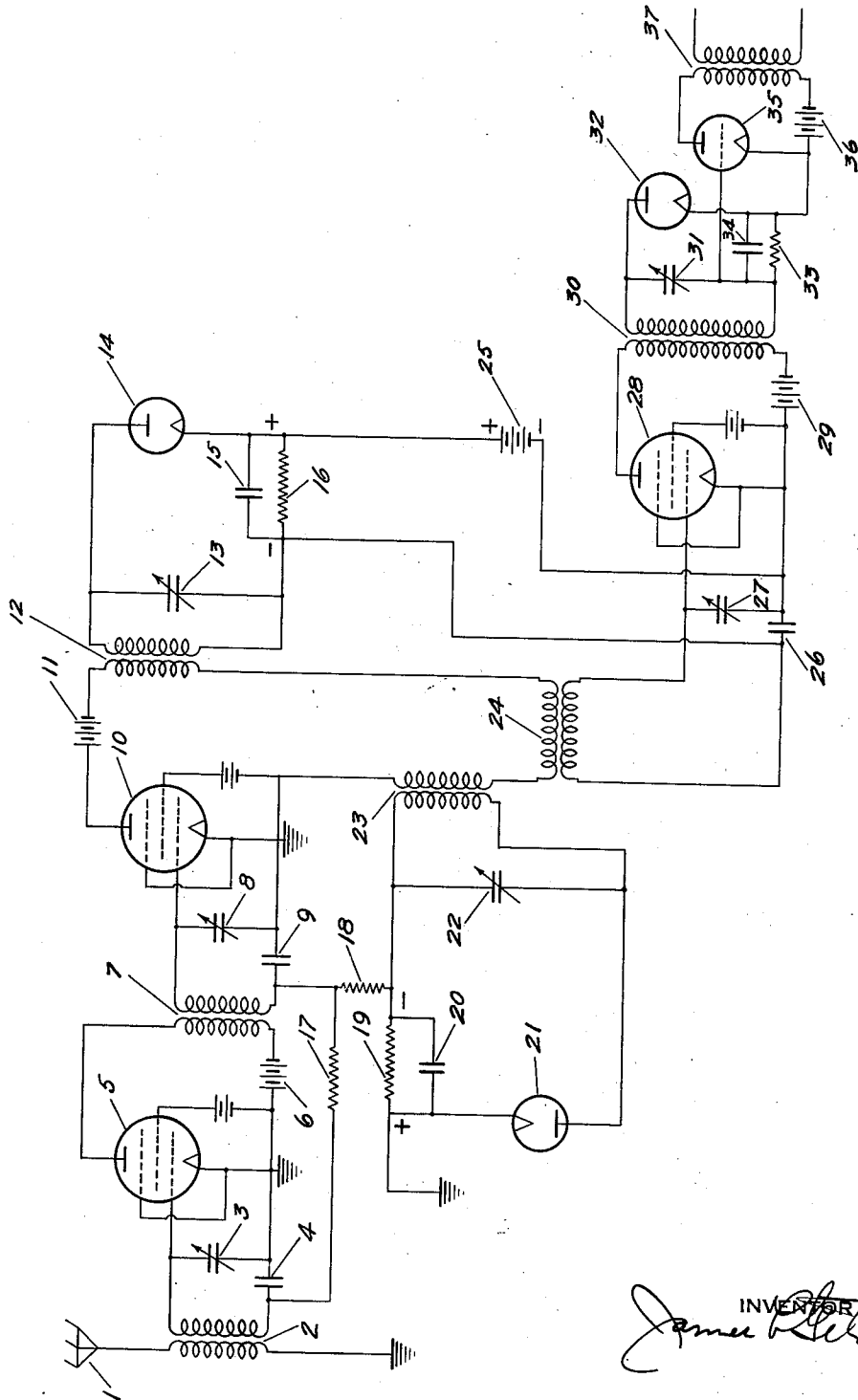
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CONTROL OF VOLUME IN RADIO RECEIVERS

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## CONTROL OF VOLUME IN RADIO RECEIVERS

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This invention relates to radio receivers and particularly to automatic volume control of the signals received.

In the method of automatic volume control now in use, only partial control is automatically obtained. In methods of this kind a voltage is obtained which is proportional to the carrier amplitude after it is amplified, and this voltage is used to regulate the amount of the amplification. It is an inherent feature of such methods of automatic control that strong signals should have a comparatively large carrier amplitude after amplification, so as to produce sufficient control voltage to control the grid voltage on the tubes which amplify the radio or intermediate frequencies. It is also necessary that for weak signals the amplified carrier amplitude be comparatively small, so that only a small control voltage will be applied to the grids of the amplifying tubes and a large amount of amplification may be obtained. The result is that while the present methods of automatic volume control greatly reduce the range of volume variation, a considerable variation of volume is left unregulated. As for example, with the automatic volume control circuits now in use, the ratio of the volume of the strong signals to the volume of the weak signals, after their amplification is controlled, may be a ratio of three to one.

The purpose of this invention is to so amplify the received signal as to obtain a uniform volume over the widest range of strength of signals received. Circuits to accomplish this purpose are shown diagrammatically in the accompanying drawing.

Signals are received from the antennae 1 and transformer 2 and amplified in the circuit of the pentode 5, which contains the tuning condenser 3, transformer 7, battery 6 and condenser 4. It is further amplified in the circuit of the pentode 10, containing condenser 9, tuning condenser 8, battery 10 and transformers 12, 23 and 24. The secondary of the transformer 23 is connected to the circuit of the diode 21, containing the tuning condenser 22, resistance 19 and condenser 20. In this circuit the current is rectified and furnishes a voltage for automatic volume control in a usual manner. The negative control voltage is applied to the grids of the pentodes 5 and 10 through the resistances 18 and 17.

The important features of this invention are related to the circuit of the diode 14. In the circuit of this tube are the secondary of the transformer 12, the tuning condenser 13, the resistance 16 and the condenser 15. In this circuit the cur-

rent is rectified and a control voltage is obtained across the resistance 16 which is similar to the control voltage obtained across the resistance 19 in the circuit of the tube 21. The positive end of the resistance 16 is connected to the positive terminal of the battery 25 (or other source of constant voltage). The negative terminal of this battery is connected to the filament of the pentode 28 and the negative end of the resistance 16 is connected to the grid of the pentode 28.

This pentode 28 provides another stage of radio amplification and its circuit contains the transformer 24, tuning condenser 27, condenser 26, battery 29 and transformer 30. The tube 32 is a detector and its circuit contains the tuning condenser 31, resistance 33 and condenser 34. The triode 35 provides the first stage of audio amplification and its circuit contains the battery 36 and the transformer 37. The secondary of this transformer connects with the loud speaker.

The operation of these circuits is as follows: The automatic volume control provided by the tube 21, regulates the amplification of the pentodes 5 and 10, so that the range of volume in the plate circuit of 10 does not vary more than 3 to 1 from the strongest to the weakest signal which it is desirable to receive. The strongest signal would produce a drop in voltage across the resistance 16 of  $7\frac{1}{2}$  volts, and the weakest signal a drop of  $2\frac{1}{2}$  volts. The battery 25 produces a constant voltage of  $2\frac{1}{2}$  volts. The pentode 28 has for normal amplification a negative voltage applied to the grid of 5 volts. If this is increased to 10 volts the rate of amplification is reduced to one-third of the rate obtained with 5 volts. When a signal is received it is amplified in the usual manner by the pentodes 5 and 10 and its amplification is controlled by the automatic control tube 21 so that the current produced in the plate circuit of 10 is limited in its variation of volume to the range obtainable by the customary automatic volume control. The battery 25 serves as a standard for comparison by which further regulation of volume may be obtained to secure greater uniformity of control. If a very strong signal is being received, which develops a voltage of  $7\frac{1}{2}$  volts across the resistance 16, this voltage is opposed by a voltage of  $2\frac{1}{2}$  volts from the battery 25, so that a negative control voltage of 5 volts is applied to the pentode 28 and its amplification is reduced to one-third the rate of normal amplification, as mentioned above. If a weak signal is received producing a voltage of  $2\frac{1}{2}$  volts across the resistance 16, it is balanced by the voltage of the battery 25, and the amplification of

tube 28 is unchanged. Under these conditions the strong signal producing  $7\frac{1}{2}$  volts across resistance 16, and the weak signal producing  $2\frac{1}{2}$  volts, would each deliver the same strength of signal to the detector 32. Should a still weaker signal be received producing less than  $2\frac{1}{2}$  volts across the resistance 16, the grid of the tube 28 will be made more positive with reference to the filament and the amplification will be correspondingly increased.

It is apparent that other combinations of voltages may be used in operating the battery 25, the resistance 16 and the pentode 28, whereby the volume may be corrected for variations which are not overcome by the control tube 21, and a uniform volume delivered to the detector for all variations of signal strength.

It is evident that these central circuits may be applied to the intermediate frequencies of a superheterodyne set, as well as to radio frequencies. Also the control circuits may be simplified by using one control tube instead of two tubes 21 and 14 as shown in the drawing. Thus the tube 21 may be made to perform the functions of both tubes by connecting the negative end of resistance 19 to the grid of pentode 28 and inserting the battery 25 or other source of constant voltage in the connection to the filament of 28. Two control tubes are shown in the drawing to more clearly illustrate the distinction between this invention and the ordinary methods of volume control.

I claim:

1. In a radio receiving set, a source of constant voltage, means for receiving electrical signals, means for amplifying said signals, means for obtaining a voltage representing the amplitude of said amplified signals, means for comparing the voltage produced by said amplified signals with said constant voltage, and means for maintaining a constant amplitude in said signals by progressively increasing the ratio of a subsequent stage of amplification of said signals when the voltage produced by said amplified signals is less than said constant voltage, according to the difference between said voltages.

2. In a radio receiving set, a source of constant voltage, means for receiving electrical signals, means for amplifying said signals, means for obtaining a voltage representing the amplitude of said amplified signals, means for comparing the voltage produced by said amplified signals with said constant voltage, and means for maintaining a constant amplitude in said signals by reducing the ratio of amplification when the voltage produced by said amplified signals is greater than said constant voltage, and means for continuing to increase the gain of said amplifying means responsive to the difference between said representative voltage and said constant voltage wherein said representative voltage is less than said constant voltage.

3. A method of receiving electrical signals, which comprises, amplifying said signals, obtaining a voltage which represents the amplitude of

said amplified signals decreasing the amplification of said signals according as said voltage is greater than a constant voltage, and continuing to increase the rate of said amplification responsive to the difference between said representative voltage and said constant voltage wherein said representative voltage is less than said constant voltage.

4. A method of controlling the rate of amplification of electrical signals, which comprises, amplifying said signals, obtaining a voltage representing the amplitude of said amplified signals, reducing the variations in amplitude by controlling the rate of said amplification by said representative voltage, amplifying said signals in a subsequent stage of amplification, controlling the rate of amplification of said subsequent stage to further reduce the variations in amplitude of said signals by a voltage produced by combining said representative voltage with a constant voltage, while said representative voltage varies from a quantity less than said constant voltage to a quantity equal to or greater than said constant voltage.

5. In a radio receiving set, means for receiving and amplifying electrical signals, means for obtaining a voltage representing the amplitude of said amplified signals, means for reducing the variations in amplitude by controlling the rate of said amplification by said voltage, a source of constant voltage, means for obtaining a control voltage by adding or subtracting said representative voltage to said constant voltage, means for controlling a subsequent stage of amplification by said control voltage, and means for changing said rate of subsequent amplification, said constant voltage being greater than said representative voltage.

6. In a radio receiving set, means for receiving and amplifying electrical signals, means for obtaining a voltage representing the amplitude of said amplified signals, means for reducing the variations in amplitude by controlling the rate of said amplification by said voltage, a source of constant voltage, means for obtaining a control voltage which is the algebraic sum of said representative voltage and said constant voltage for all values of said representative voltage, means for further reducing the variations in amplitude of said signals by controlling a subsequent stage of amplification by said control voltage.

7. In a radio receiving set, means for receiving and amplifying electrical signals, means for obtaining a voltage representing the amplitude of said amplified signals, means for reducing the variations in amplitude by controlling the rate of said amplification by said voltage, a source of constant voltage, a subsequent stage of amplification, means for amplifying said signals to a constant amplitude in said subsequent stage of amplification by applying both said constant voltage and said representative voltage to an amplifying means to control the rate of amplification in said subsequent stage.

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