July 7, 1936. K. A. CHITTICK 2,047,003

VOLUME CONTROL SYSTEM

Filed June 29, 1933

Fig. 1.

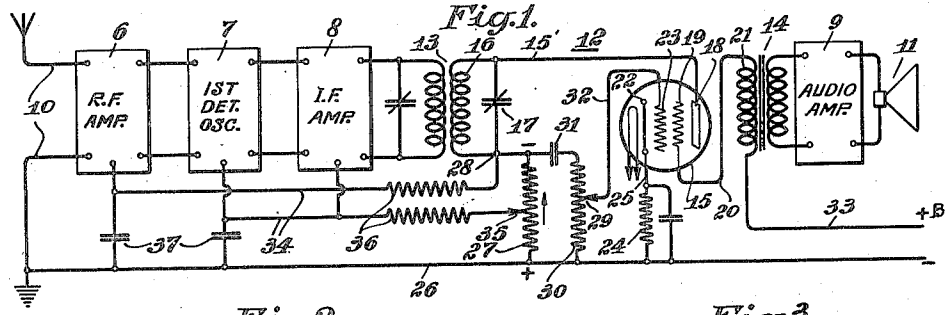


Fig. 2.

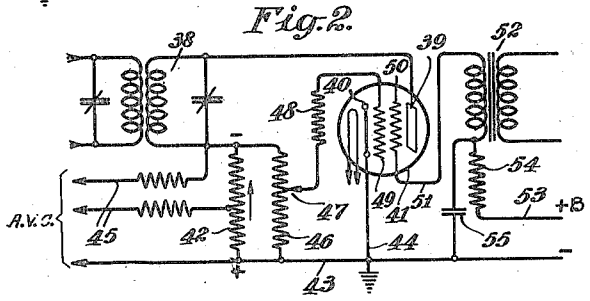


Fig. 3.

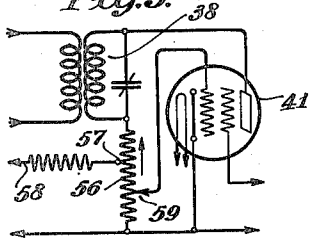


Fig. 4.

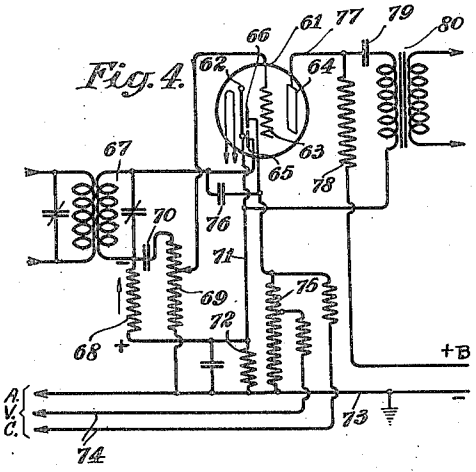


Fig. 5.

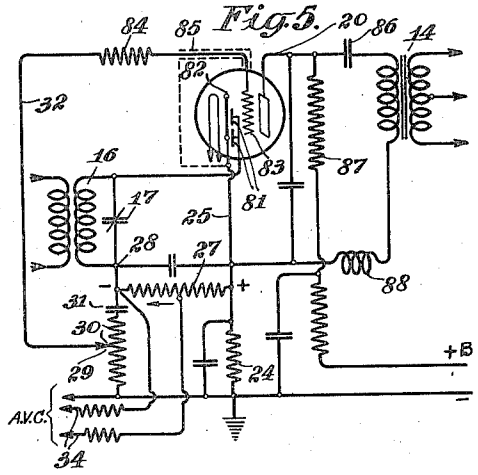
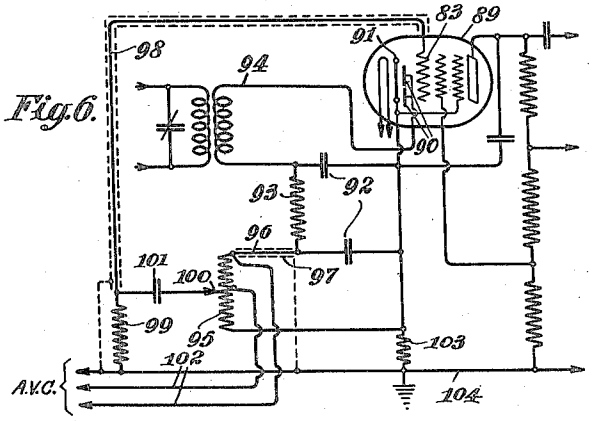


Fig. 6.



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UNITED STATES PATENT OFFICE

2,047,003

VOLUME CONTROL SYSTEM

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Application June 29, 1933, Serial No. 678,153

13 Claims. (Cl. 250—20)

The present invention relates to volume control systems for radio receiving apparatus and the like and has for its primary object to provide an improved system of that character.

More particularly, the present invention relates to a volume control system, including a modulated signal detector or rectifier of the electric discharge or vacuum tube type, with which is combined a plurality of signal circuits, whereby the electric discharge device may have a plurality of functions in the system.

A further and more specific object of the invention is to provide a combined detector or rectifier and volume control circuit, the volume control portion of which is arranged to supply a variable audio frequency signal potential and a signal controlled direct current bias potential for automatic volume control apparatus.

The invention will, however, be understood more fully from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Figure 1 is a schematic circuit diagram of a radio receiving system embodying the invention; and

Figs. 2, 3, 4, 5, and 6 are similar circuit diagrams showing modifications of the system illustrated in Fig. 1.

Referring to Fig. 1, the radio receiving system is provided with a radio frequency amplifier 6, a first detector and oscillator 7, an intermediate frequency amplifier 8, an audio frequency amplifier 9, providing a signal transmission channel between a source of modulated signals, represented by an antenna circuit 10, and a suitable sound producing or output device such as a loudspeaker 11.

Interposed between the intermediate frequency amplifier 8 and the audio frequency amplifier 9 is a combined detector and volume control circuit 12 which is provided with a tuned high frequency input transformer 13 and an audio frequency output transformer 14 connected with the audio frequency amplifier 9.

Transformers 13 and 14 represent any suitable input and output coupling elements for a vacuum tube detector and amplifier device 15. In the present example, the transformer 13 is provided with a secondary winding 16 which, in conjunction with a variable condenser 17, provides a tuned input circuit for the device 15. In the case of the superheterodyne circuit arrangement, the circuit 16, 17 may be tuned to the intermediate frequency.

The tuned circuit is connected with an input electrode 18 in the device 15 through a suitable high frequency input lead 15'. The device is further provided with a suitable output electrode 19 which is connected with an output circuit 20, in turn connected with the primary winding 21 of the audio frequency output transformer 14. The device 15 is further provided with a cathode 22 which is of the indirectly heated type as indicated and an electrode 23.

In one embodiment of the invention, the device may be of the screen grid amplifier type in which the electrode 23 is an inner grid normally utilized as a control grid, the electrode 19 is the screen grid and the electrode 18 is the normal anode or plate electrode. In this circuit, in accordance with the invention, the anode 18 is utilized as an input anode for a diode rectifier, the other element of which is the cathode 22. The diode rectifier circuit is completed through a self bias resistor 24 in the cathode lead 25, thence through a ground or common return lead 26, and through an impedance device 27 to the low potential end 28 of the tuned signal input circuit.

It will be seen from the foregoing description that a diode rectifier and an electrical impedance device are connected in series with a signal transmission circuit, such as the circuit 16, 17, whereby signal potentials are applied to the rectifier. Means are provided whereby a variable tap connection is made with the impedance device 27 for controlling the application of signal potentials to the electrode 23 as the control grid of a vacuum type amplifier.

In the present example, the variable tap connection is indicated at 29 in connection with a resistor 30 connected in parallel with the impedance device 27 through a suitable coupling condenser 31. In this circuit arrangement, it will be noted that the impedance device 27 is connected between the low potential end 28 of the signal input circuit and ground lead 26. The resistor 30 is connected in the same manner with one terminal at ground potential as indicated.

The movable tap 29 provides, in connection with the resistor 30, a potentiometer for controlling the rectified signal potential on the grid or electrode 23, the tap 29 being connected with the grid 23 through a lead 32. With this arrangement, as the tap 29 is moved in the direction of the terminal of the resistor 30 which is connected to the ground lead 26, the potentials applied to

the grid are reduced and the output signal volume of the system thereby adjusted to the desired level. It will also be noted that as the tap is moved toward the ground terminal, the grid 23 is operated more nearly at ground potential.

The grid 23 further receives a normal operating bias potential from the self bias resistor 24 through the potentiometer 30 and the ground lead 26. With the self bias resistor 24 utilized as a source of bias potential for the grid 23, the condenser 31 is necessarily interposed between the grid circuit 32 and the impedance device 27 in order to prevent direct biasing potentials, from the impedance 27 as a source, from reaching the grid 23. Suitable operating anode potential is applied to the electrode 19, as an anode, through the circuit 20, 21 from a positive supply lead indicated at 33.

There are also provided in connection with the impedance device 27, one or more supply leads, indicated at 34, for gain control purposes in connection with the preceding amplifier circuits. Any suitable connection for automatic volume control purposes may be provided.

In the present example, the leads 34 are connected with the radio frequency amplifier, first detector and intermediate frequency amplifiers as indicated for controlling the gain therethrough in response to changes in value of the rectified signal component existing in the impedance device 27. Suitable lower potentials as desired for certain control purposes may be obtained by tapping the resistor 27 as at the tap 35, for example.

In order to prevent feed-back of high frequency energy to the preceding amplifier through the automatic volume control connection, the leads 34 are preferably provided with impedance elements 36, such as resistors with relatively high resistance value, and suitable by-pass condensers 37 from each lead to ground, as indicated, to provide a high frequency filter in each lead.

It has been found that a suitable filter may be provided if the impedance of the devices 36 are relatively higher in impedance value than the impedance device 27 in the diode rectifier circuit. By way of example, in a preferred circuit arrangement of the character described, the impedance of the device 27 may be substantially 60,000 ohms, while the impedance of the devices 36 may have a value of from 1 to 2 megohms and the condensers 37 may have a value of substantially .05 microfarad. In this connection also, it may be said that with the values given, the values of the shunt volume control device 30 and the coupling condenser 31 may be substantially 2 megohms and .05 microfarad, respectively.

It will be noted that the cathode 22 is common to both the diode rectifier and the triode amplifier and all of the elements of both the amplifier and the rectifier are located in the same envelope. Such a combined detector and amplifier, suitable for use in a volume control circuit embodying the invention and adapted to provide the specific circuit shown in Fig. 1, is a screen grid amplifier device, commercially known as the RCA—224 tube.

The operation of the system shown and described is as follows:—Signal voltage is impressed across the high frequency input circuit 16, 17, and the positive half waves are rectified between the anode 18 and the cathode 22. The rectified or direct current component of the signal flows in the direction of the arrow through the impedance device 27, thus causing the upper end thereof, or terminal 28, to assume a negative potential with respect to ground. The rectified or audio frequency modulation or the modulation signal current also appears as a signal potential across the impedance device 27.

The modulation or audio frequency component of the rectified signal is transferred through coupling condenser 31 to the volume control potentiometer 30 and is impressed upon the control grid 23 through the lead 32 from the variable tap 29 on the resistor 30. This signal component is thereby controllable in order to control the signal output volume. At the same time, this control prevents the application to the grid 23 of a signal sufficiently great to cause overloading, that is, to exceed the normal biasing potential supplied from the source 24.

The audio or modulation frequency signal applied to the grid 23 is amplified in the triode arrangement provided by the cathode 22, the grid 23, and the electrode 19, the latter operating as an anode. The amplified audio frequency signal is conveyed through the output circuit 20 and the coupling device 14 to the audio frequency amplifier 9 and thence to the output or sound reproducing device 11.

It will be appreciated that in the customary automatic volume control circuit, the control cannot ordinarily be made flat in its operating characteristic for the reason that an increase in signal voltage on input circuit, such as the circuit 16, 17, for example, is required to produce additional automatic volume control biasing potential, such as that produced across the impedance 27 for application to the preceding amplifier device through the control leads 34.

With such arrangement, the grid circuit of the triode section above referred to, may receive excessive audio frequency potentials on strong signals, and may overload either in the grid or plate circuit, thereby causing distortion. A manual volume control device is, therefore, in accordance with the invention, introduced in circuit between the source of audio frequency signals and of volume control potentials, and the control grid of the amplifier which is to receive the audio frequency signals.

The tap connection 35 for automatic volume control purposes, is preferably variable, as indicated, whereby the control potentials supplied through the leads 34 may be varied to increase or decrease the effect of variations in signal strength on the preceding amplifier and detector stages. In the normal operation of the system, the adjustment is such that the control potentials derived from the tap 35 may cause a reduction in the gain of the system only after the received signal strength is above a certain predetermined level.

In the circuit of the present example, the amplifier receives a fixed bias potential independent of variations in the signal strength. In certain circuits it has been found to be desirable to obtain the biasing potential for the amplifier grid also from the rectified signal current whereby the vacuum tube device is "diode biased".

It will be noted that the potentiometer 30 being connected to the ground lead 26, is connected to the negative end of the self bias resistor 24. The rectifier circuit impedance 27 is also so connected and, therefore, receives the same potential since the cathode is common to both the rectifier and the amplifier circuits. Therefore, a positive potential normally exists on the cathode 22 with respect to the diode rectifier anode 18, which potential is equal to the bias potential set up by the

self bias resistor 24. It is obvious that with this arrangement no rectification of signals, and accordingly, no detection or automatic volume control action is obtained until the positive signal potential applied to the anode 18 exceeds the potential existing on the cathode 22. Thus, with this circuit arrangement, "delayed" detector and automatic volume control functions are obtained by common means and with a simple circuit arrangement.

This circuit arrangement is desirable for the purpose of causing the receiving system to operate to transmit signals through it only when such signals are above a predetermined desired strength or value. Therefore, a system of this character may be arranged to permit the reception of only such signals as have sufficient strength to permit reception with reasonable volume and clarity.

In certain receiving systems, however, such delayed detection and automatic volume control operation may be undesirable and by a simple change in the circuit, the delayed operating action in either the detector or the automatic volume control circuits may be provided, as will hereinafter be pointed out in connection with certain of the succeeding embodiments of the invention to be described.

A modification of the circuit 12 wherein a "diode biased" amplifier, hereinbefore mentioned, is utilized in a volume control system embodying the invention, is shown in Fig. 2, to which attention is now directed.

In Fig. 2, the signal input circuit, indicated at 38, is connected through a diode rectifier comprising an anode 39 and a cathode 40 in a vacuum tube device 41, thence through an impedance element 42, and returning to the circuit 38, thereby forming a diode rectifier circuit similar to that of the preceding figure, except that in this circuit the cathode 40 is returned directly to ground or to the low potential lead 43 through a lead 44 without including a fixed source of bias potential.

The automatic volume control connections 45 are provided in connection with the impedance device 42 which is preferably a resistor or a series of resistors, and a volume control potentiometer is provided in shunt thereto as indicated at 46, the variable tap 47 being connected through a filter resistor 48 to the control grid indicated at 49. An electrode 50 is connected as an output anode to an output circuit 51 with an audio or modulation frequency output coupling device 52 through which operating anode potentials are supplied from a lead 53 through a regulating resistor 54, the latter being suitably by-passed by a condenser indicated at 55.

The operation of the system shown is as follows:—The rectified modulation or audio frequency signal potential appearing across the impedance device 42 is applied directly to the shunt connected potentiometer 46 and is, by the adjustment of the contact 47, applied to the grid 49 at a proper controllable potential to provide a desired output volume and prevent overloading on strong signals. The resistor 48 serves as a filter for preventing the application to the grid 49 of any high frequency signal potential included in the diode output circuit and the potentiometer 46.

It has hereinbefore been noted that the potentiometer 46 is connected directly to the impedance 42. This is for the reason that the direct current component of the signal is utilized to set up a biasing potential on the grid 49, an increasing biasing potential being applied as the potentiometer contact 47 is moved in a direction to increase the signal volume. The control grid 49, therefore, receives from the diode rectifier circuit or from the impedance 42 both the audio frequency signal component and the direct current component of the signal. When the signal is zero, no current flows in the impedance 42 and the parallel connected impedance 46. Therefore, a zero bias is applied to the control grid 49 with the result that with no signal, the plate current flowing to the anode 50 would reach excessively high values were it not for the regulating resistor 54 connected in series with the anode electrode 50.

The amplifier is thereby caused to have a relatively high gain for weak signals because of the low or substantially zero bias resulting from such signals.

At the same time that the grid 49 receives simultaneously controlled and variable signal and biasing potentials from the impedance 42, the automatic volume control circuit leads 45 receive variable potentials responsive to variations in the direct current signal component, whereby automatic volume control of preceding amplifier devices and the gain therein may automatically be obtained without further circuit complications.

In certain instances and in order to provide a more simplified system, the potentiometer 46 and the impedance 42 may be combined in one device such as indicated in the circuit modification shown in Fig. 3 wherein, in connection with the input circuit 38, a single tapped impedance device or resistor 56 corresponding to the resistor or potentiometer 46 of Fig. 2 is provided with a fixed tap 57 from which are taken automatic volume control potentials directly through the lead 58. The potentiometer device is further provided with the variable tap 59 for applying to the amplifier and rectifier 41, controllable signal and bias potentials resulting from the flow of the rectified signal current through said device.

With further reference to the circuits shown in Figs. 2 and 3, it will be seen that the rectified signal current flows in the impedance in the diode rectifier circuit in the direction indicated by the arrow in each figure, and that the flow of the direct current component of the signal in the direction indicated, causes a negative bias to be applied to the grid of the amplifier whenever the volume adjustment is increased above zero and with the signal being received. It will further be seen that if an adjustment is selected with the potentiometer tap approximately nearer the grounded end of the potentiometer, there will be less negative bias at this point and simultaneously also less audio frequency potential applied to the amplifier control grid.

At the ground point or ground lead 43, for example, in Fig. 2, there will be no bias voltage available and likewise, no audio frequency voltage. Sufficient bias will, therefore, always be applied to the grid when receiving a signal to provide against overloading on audio frequency modulation. At 100% modulation, the bias voltage created for the control grid is slightly more than the audio frequency voltage applied. At 30% modulation, the audio frequency voltage applied to the grid is approximately one third of the bias created to carry the signal. The signal control of the bias and signal potentials simulta-

neously, is therefore, provided by simple circuit means, and is desirable for the further reason that the usual separate source of biasing potential is thereby eliminated and the operation of the amplifier is improved.

Furthermore, if no volume control means, such as the potentiometer were provided, the control grid of the audio frequency amplifier would receive an excessive bias potential on strong signals and would drive the anode current to cut off, causing distortion. This is prevented to a large extent by the automatic bias applied to the grid, which automatically reduces the plate current and therefore raises the plate voltage as the signal increases, because of the lower potential drop in the regulating resistor **54**.

It may also be pointed out that the circuits shown in Figs. 2 and 3, using "diode bias", require fewer circuit components and may be greatly simplified, as indicated in the drawing. Such circuits have the advantage that the bias potential required for the grid of the audio frequency amplifier is provided by the signal itself and is varied at the same time that the audio frequency potential is varied through the volume control circuit provided.

In connection with Fig. 3, it will be noted that the automatic volume control lead **58** is provided in connection with a tap **57** at an intermediate point on the impedance **56**, while the tap **59** for the amplifier may be moved to any position such as the extreme upper end, as viewed in the drawing, to take therefrom the maximum audio frequency signal. The automatic volume control tap, therefore, may receive a lesser direct potential for automatic volume control purposes. This is also true of the automatic volume control tap connection shown in the circuit of Fig. 2, where an automatic volume control tap connection is made on the diode circuit impedance **42**.

With this arrangement, the receiving system is permitted to build up relatively high signal output level because the automatic volume control bias is delayed. Therefore, a louder or stronger output signal level may be obtained when receiving from weak or distant transmitting stations. The arrangement is such that the impedance in the rectifier circuit is tapped at such a point that more audio frequency potential may be developed for the audio frequency amplifier than for the supply of automatic volume control bias potentials.

Referring now to Fig. 4, the vacuum tube device **61** is provided with a cathode **62** for a triode amplifier device comprising in addition, a grid **63** and a plate or anode **64**, and two anodes **65** and **66** associated directly with the cathode **62** to provide separate diode rectifiers. One anode **65** is provided as an anode for a signal rectifier in connection with the high frequency modulated signal input circuit indicated at **67** and the rectified signal component is impressed across the rectifier circuit impedance indicated at **68**. The audio frequency component of the signal is applied to the control grid **63** through a volume control device indicated at **69**, connected in shunt relation to the impedance **68** through a suitable coupling condenser **70**.

It will be noted that the signal rectifier circuit is connected directly to the cathode lead indicated at **71** and does not include a self bias resistor **72** whereby the signal diode **65** is directly operative in response to low signal potentials without any delayed action, as is characteristic of the circuit shown in Fig. 1. However, the same delayed action may be obtained by connecting the impedance **68** directly to the ground lead **73**, as shown in Fig. 1.

In this embodiment of the invention, the automatic volume control circuit leads **74** are supplied from a separate voltage divider or impedance **75** through a separate diode rectifier provided by coupling the anode **66** through a coupling condenser **76** with the signal input circuit **67** in parallel with the signal diode rectifier plate **65**.

It will be noted that the impedance **75** is connected to the ground lead **73**, whereby the bias potential existing in the self bias resistor **72** is applied to the cathode to prevent a rectifying action between it and the anode **66** until a positive signal potential greater than the amplifier bias potential is received whereby the automatic volume control function may be delayed while the detector or rectifier action is made responsive directly to any signals received. In the present example, the automatic volume control delay is equal to the normal bias on the control grid of the audio frequency amplifier which may be any required potential such as 6 to 8 volts, for example.

In the present circuit the normal anode **64** is used as the audio frequency signal output anode in connection with the audio frequency output circuit indicated at **77** in connection with which is provided a suitable output coupling impedance **78**, a coupling condenser **79** and an output transformer **80**. The coupling impedance **78** may be a resistor like that at **54** in Fig. 2 and may be used for the same purpose in such a circuit.

It will be noted that in connection with the circuit shown in Fig. 4, a device having separate diode rectifier plates may be used whereby the electron stream for the diode rectifier and automatic volume control rectifier may be separated from the electron stream of the amplifier device. The use of a separate anode or anodes has that advantage and the further advantage that the detector and automatic volume control functions may be separated. A device suitable for use in the circuit of Fig. 4 is a vacuum tube device known commercially as RCA—55 tube. The further use of such a tube in a circuit similar to that of Fig. 1 is shown in Fig. 5 to which attention is now directed, and in which the same reference numerals for like parts have been used.

In this circuit, both diode plates **81** are connected in parallel to the signal input circuit provided by the winding **16** and the condenser **17** and provide a dual plate rectifier in conjunction with the cathode **82**. The rectifier circuit includes an impedance element **27** connected between the cathode lead **25** and the low potential terminal **28** of the input circuit. It will be noted that the impedance **27** is connected to the cathode lead **25** on the cathode side of the self bias resistor **24**, whereby the bias potential developed in the resistor **24** is prevented from setting up a delay potential on the anodes **81**, and whereby, as distinguished from the circuit of Fig. 1, no delayed detection and automatic volume control action is provided.

The coupling condenser **31** and volume control potentiometer resistor **30**, having a movable tap contact **29**, is provided for volume control purposes in connection with the control grid **83**, the grid lead **32** in which is connected a suitable filter resistor **84** being connected with the tap

29. The lead is also electrically shielded adjacent to the grid for at least a portion of its length and the shield, indicated at 85, is connected to ground, or, in the present example, to the cathode, as indicated.

The output anode circuit 20 includes an output coupling device 14 provided with a suitable coupling condenser 86 and coupling impedance 87 whereby plate current is prevented from flowing in the output device 14 as is well known in audio frequency circuits. This output circuit is similar to that shown in Fig. 4.

A choke coil 88, also in series with the output circuit, serves to increase the high frequency audio signals which have been attenuated by the radio circuits and detector system.

The automatic volume control leads indicated at 34 are connected in the same manner as in Fig. 1 referred to. No further description is believed necessary since the operation is the same as described for the circuit of Fig. 1 except for the change whereby detection and automatic volume control are not delayed.

Referring now to Fig. 6, a circuit similar to that of Fig. 5 is shown except that a screen grid pentode 89 is utilized in the same envelope with two diode plates 90 associated with the common cathode 91.

In this circuit, a more complete intermediate or high frequency filter is provided than in the preceding figure wherein the impedance of the resistor 84 and the distributed capacity of the shield 85 are depended upon to by-pass intermediate frequency signal components from the grid 83. In this circuit, a ladder filter comprising two by-pass condensers 92 and a filter resistor 93 are provided between the signal input circuit indicated at 94 and the rectifier circuit impedance indicated at 95. Between the filter and the impedance device 95, the connection lead 96 therefor is electrically shielded and grounded as indicated at 97.

In this embodiment of the invention, the shielded amplifier grid lead, indicated at 98, is connected to a coupling resistor 99 and the variable tap 100 for volume control purposes is provided directly on the rectifier circuit impedance 95. A coupling condenser 101 provides a signal conducting path between the impedance 99 in the grid circuit and the tap 100. The rectified circuit impedance 95 is also tapped for automatic volume control purposes, as indicated, to provide a connection for the automatic volume control circuit leads 102. Self bias potentials are obtained from the cathode lead resistor 103 through the grid lead 98 and the impedance 99 which is connected, in common with the resistor 103, to the ground lead 104. The potentiometer volume control impedance 95 may be a resistor having a resistance value of several thousand ohms and the impedance element 99 may then have a resistance value of two megohms for example. It has been found that ordinarily the volume setting is relatively low for ordinary radio signals for normal signal output. Accordingly the resistance provided by the impedance element 99 may be reduced in value correspondingly and may be of a corresponding order of several thousand ohms without introducing distortion in the signal amplification.

It has been found that a tendency toward signal distortion is obtainable relatively only when the volume setting of the device 95 is at or near maximum, in which position it is seldom used in actual operation.

Accordingly, it is possible to utilize a much lower coupling impedance at 99 approaching in resistance value that of the volume control device 95.

As the remaining features of the circuit shown have already been shown and described in connection with preceding figures, further description is believed to be unnecessary.

From the foregoing description it will be seen that there may be provided in a radio receiving system a volume control potentiometer for preventing signal overloading on the grid of a modulation or audio frequency amplifier following a diode detector circuit which is arranged to supply automatic volume control potentials. The system includes essentially a diode rectifier and an electrical impedance device in series in a signal transmission circuit together with means for applying signal potentials to said rectifier, means providing a variable tap connection with said impedance device to apply a controllable potential to a modulation or audio frequency amplifier, the diode rectifier and the amplifier have a common cathode and amplifier having a separate output circuit together with means for applying signal generated potentials to other amplifiers for gain control purposes.

With the system shown and described, clear undistorted signal output such as music and speech may be obtained from a radio receiving system having a wide range of automatic volume control in connection with a simple diode rectifier circuit for both automatic volume and audio frequency purposes through the control of potential supplied to the grid of the amplifier following the diode rectification.

I claim as my invention:

1. In a radio receiving system, the combination with an electric discharge device providing a diode rectifier and an amplifier having a control grid, of a signal input circuit connected to said rectifier, an electrical impedance device in circuit with said rectifier to receive the rectified signal output therefrom, and means providing a variable connection for said grid with said impedance device for applying to said grid a selected portion of the potential existing across the impedance device as the result of the flow therein of rectified signal current.

2. In a radio receiving system, a diode output resistor, diode rectifier means for applying to said resistor a rectified radio signal current, said means including an electric discharge device having rectifier elements connected in circuit with said resistor and having a control grid, and means providing a variable connection with said control grid for said resistor, said last named means comprising a potentiometer resistor connected in parallel with the diode output resistor and having a resistance so high with respect to that of the first named resistor that it provides substantially no load on said first named resistor and the diode rectifier circuit.

3. In a radio receiving system, a rectifier, means for applying to said rectifier modulated high frequency radio signals, an impedance in circuit with said rectifier for receiving the rectified current output therefrom, means for selecting direct current potentials from said impedance means, and means for selecting the rectified signal component of said current from said impedance means, said selecting means being variable and comprising a potentiometer resistor connected in parallel with said impedance means, said potentiometer having a variable volume con-

trol tap and having a resistance greater than that of the impedance means, and an amplifier grid circuit connected with said variable tap.

4. In a radio receiving system, the combination with a high frequency amplifier having an automatic volume control circuit, of a rectifier comprising an anode and a cathode electrode connected with said amplifier to receive at least a portion of the signal output therefrom, an impedance device in circuit with said rectifier to receive the rectified current output therefrom, an electrical filter providing a connection between the automatic volume control circuit and the impedance device, said filter including an electrical impedance device of a relatively higher value than the impedance of said first-named impedance device, a grid and a second anode associated with said cathode to provide an electric discharge amplifier, a signal output circuit connected with said last-named anode, and a potentiometer device connected in parallel with and having an impedance higher than that of said first-named impedance device by an amount sufficient to provide substantially no load thereon, and said potentiometer device having a variable tap connection for said control grid.

5. In combination, a signal source, a diode rectifier having an anode and a cathode connected with said signal source for rectifying signals received therefrom, a diode rectifier output impedance in said connection between the cathode and said signal source, potentiometer means conductively connected in shunt with said output impedance, a grid and a second anode associated with said cathode to provde an electric discharge amplifier, and means providing a variable tap connection between the control grid and the potentiometer means whereby said amplifier device receives biasing and signal potentials simultaneously from said potentiometer means in response to signals, said potentiometer means having a relatively high impedance thereby to provide a relatively light load on said diode output impedance.

6. In a radio receiving system, the combination of a signal input circuit, a rectifier having an anode connected with said circuit and having a cathode, a control grid, and a second anode associated with said cathode to provide an electric discharge amplifier associated with said rectifier, a volume control potentiometer connected between the cathode and said signal input circuit, said potentiometer having a movable tap connected with the control grid.

7. In a radio receiving system, the combination of a signal input circuit, a rectifier having an anode connected with said circuit and having a cathode, a control grid, and a second anode associated with said cathode to provide an electric discharge amplifier associated with said rectifier, a volume control potentiometer connected between the cathode and said signal input circuit, said potentiometer having a movable tap connected with the control grid, and an electrical filter between said input circuit and said potentiometer device.

8. In a signal receiving system, a signal circuit including a diode signal rectifier and a diode output impedance connected in series, an electric discharge amplifier device having a control grid connected with said impedance to receive signal potentials therefrom, and variable means conductively connected with and interposed between said source of rectified current and the control grid for controlling the amplitude of the signals derived therefrom for application to said control grid, said means having a relatively high impedance with respect to said diode output impedance, thereby to provide substantially no load thereon and reduce signal distortion.

9. In a radio receiving system, the combination of a modulated radio signal input circuit, a diode rectifier and a direct current impedance device connected in series with said circuit, a radio signal amplifier connected with said impedance device to receive controlling direct current biasing potentials therefrom, a high impedance filter means in said connection, the impedance of which to rectified signal current is greater than that of said impedance device, a potentiometer device connected in parallel with said impedance device, a second amplifier connected with a variable tap on said potentiometer device to receive biasing and signal potentials therefrom, and said devices having an impedance ratio of at least five to one, the potentiometer device having the higher impedance, whereby the lower impedance device is not appreciably loaded and signal distortion thereby is substantially prevented.

10. In a radio receiving system, a diode rectifier, means for applying to said rectifier modulated high frequency radio signals, an output impedance in circuit with said rectifier for receiving the rectified current output therefrom, means for selecting direct current potentials from said impedance means, and means for selecting the rectified signal component of said current from said impedance means, said selecting means being variable and comprising a potentiometer resistor connected in parallel with said output impedance, said potentiometer having a variable volume control tap and having a resistance greater than that of the impedance means by an amount sufficient to provide substantially no load thereon, and an amplifier grid circuit connected with said variable tap.

11. In a radio receiving system, the combination with an electric discharge device providing a diode rectifier and an amplifier having a control grid, of a signal input circuit connected to said rectifier, an electrical impedance network in circuit with said rectifier to receive the rectified signal output therefrom, and means providing a variable connection for said grid with said impedance network for applying to said grid a selected portion of the potential existing across the impedance network as the result of the flow therein of rectified signal current.

12. In a radio receiving system, a diode output resistor, diode rectifier means for applying to said resistor a rectified radio signal current, said means including an electric discharge device having rectifier elements connected in circuit with said resistor and having a control grid, and capacity coupling means providing a variable connection with said control grid for said resistor, said last named means comprising a coupling capacitor, a potentiometer resistor connected in parallel with the diode output resistor through said capacitor and having a resistance so high with respect to that of the first named resistor that it provides substantially no load on said first named resistor and the diode rectifier circuit.

13. In a radio receiving system, a diode output resistor, diode rectifier means for applying to said resistor a rectified radio signal current, said means including an electric discharge device having rectifier elements connected in circuit

with said resistor and having a control grid, and capacity coupling means providing a variable connection with said control grid for said resistor, said last named means comprising a coupling capacitor, a potentiometer resistor connected in parallel with the diode output resistor through said capacitor and having a resistance so high with respect to that of the first named resistor that the numerical value of the impedance to audio frequency currents through said network is less than the direct current resistance thereof.

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