Dec. 28, 1937. W. J. POCH 2,103,637

AUTOMATIC VOLUME CONTROL CIRCUIT

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Fig. 1.

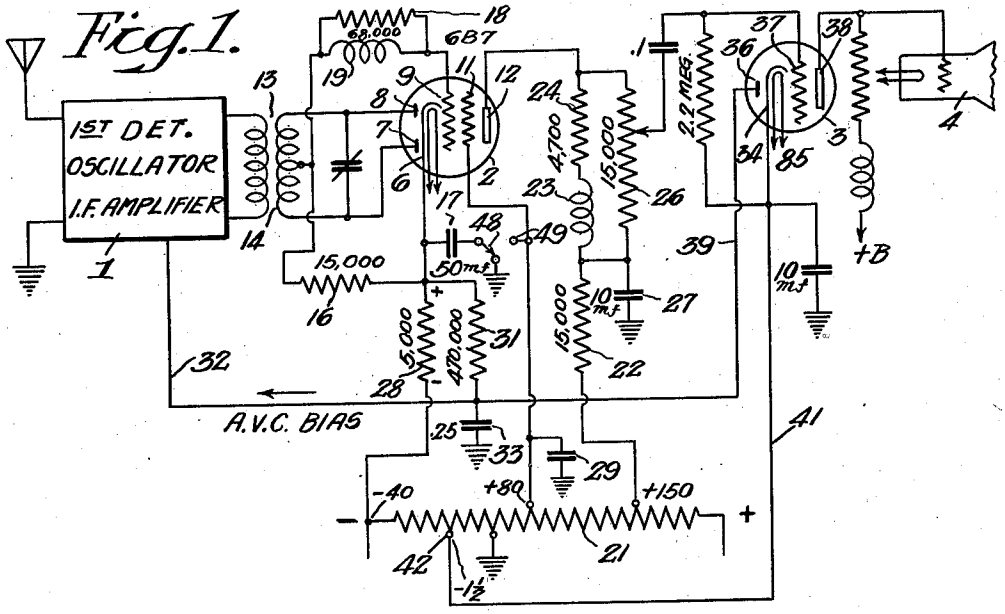
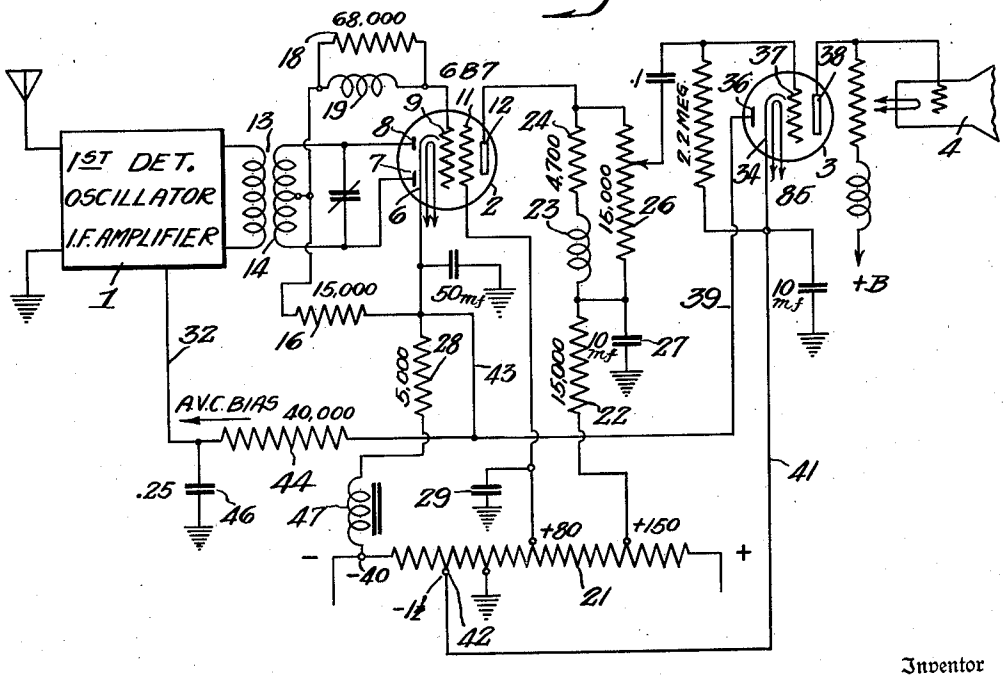


Fig. 2.



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AUTOMATIC VOLUME CONTROL CIRCUIT

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10 Claims. (Cl. 250—20)

My invention relates to radio or television receivers and particularly to automatic volume control circuits for such receivers.

In automatic volume control circuits of the general type wherein an amplifier tube is biased increasingly negative in response to an increase in signal amplitude and wherein a volume control signal is obtained from a resistor in the cathode lead of said tube, it has been found that unless certain precautions are taken the grids of tubes receiving the control voltage will be positive when the incoming signal is below a predetermined amplitude. Because of this, the life of the tubes may be shortened considerably as a result of the heavy plate current.

It is accordingly an object of my invention to provide an improved automatic volume control circuit which does not damage the receiver tubes.

A further object of my invention is to provide a volume control circuit of the above-mentioned type which does not apply any substantial positive voltage to the grids of the tubes receiving the control voltage.

A still further object of my invention is to provide an improved automatic volume control circuit which applies a control voltage to the amplifier tubes only when the incoming signals exceed a predetermined amplitude.

Other objects and advantages of my invention will appear from the following description when taken in connection with the accompanying drawing in which

Figure 1 is a circuit diagram of one embodiment of my invention, and

Figure 2 is a circuit diagram of another embodiment of my invention.

Referring to Figure 1 my invention is shown applied to a television receiver which may be of the superheterodyne type including the first detector and oscillator and an intermediate frequency amplifier as indicated by the rectangle 1. The receiver also includes a first detector and video amplifier which may be combined in a single envelope 2 and a second video amplifier 3 which supplies signal to a cathode ray tube indicated at 4.

The combined detector and amplifier tube 2 includes an indirectly heated cathode 6, a pair of diode plates 7 and 8, a control grid 9, a screen grid 11 and an anode 12, the cathode 6 functioning as a cathode for both the diode plates and the screen grid amplifier tube.

Diode plates 7 and 8 are connected to opposite terminals of a tuned intermediate frequency transformer 13 having a secondary 14. The center point of the transformer secondary 14 is connected through a resistor 16 to the cathode 6, the cathode 6 being maintained at ground potential so far as video signals are concerned by means of a by-pass condenser 17 of fairly large capacity. It will be seen that the circuit just described functions as a full-wave rectifier to detect the intermediate frequency picture signal whereby the picture or video frequencies appear across the resistor 16. These video signals are impressed upon the control grid 9 by means of a connection from the mid-point of the transformer secondary 14 through a resistor 18 and a parallel inductance coil 19 to the control grid 9. The inductance coil 19 is provided to build up the high frequency response of the amplifier by resonating with the input capacity of the tube 2. The resistor 18 shunted across the inductance coil provides sufficient damping to prevent the resonant peak from being too high.

It will be understood that since a current flowing through the resistor 16 is the output of a double-wave rectifier it will contain a direct current component, this component increasing in value with an increase in the strength of the incoming signals. Since the flow of current through the resistor 16 is in such a direction as to make the control grid 9 more negative as the current flow increases, an increase in signal strength will cause a decrease in plate current through the amplifier tube.

Considering now the plate circuit of the amplifier tube, the plate 12 is supplied with positive potential from a suitable direct current source such as the voltage divider 21 (connected to a power supply unit not shown) through a filter resistor 22, a peaking coil 23 and a plate resistor 24. The peaking coil 23 and plate resistor 24 are shunted by the potentiometer resistor 26 from which picture signal is taken and supplied to the amplifier 3. The lower end of the peaking coil is connected to ground for video frequencies by means of a suitable by-pass condenser 27.

The cathode 6 is connected to the negative terminal of the voltage divider 21 through a cathode resistor 28. It will be apparent that the plate current flows through the cathode resistor 28 and that the voltage drop thereacross depends upon the strength of the incoming signal.

The screen grid 11 is connected to a suitable positive point on the voltage divider 21 and is connected to ground for video frequencies through a by-pass condenser 29.

The volume control voltage is taken from the cathode end of the cathode resistor 28, the con-

nection from this control point to the grids of the intermediate frequency amplifiers including a resistor 31 and a conductor 32. A condenser 33 is provided between the lower end of the resistor 31 and ground to filter out any hum or signal that may be present on the cathodes of the tubes 2 and 3.

It will be noted that, considering resistor 28 and 21 in series, the voltage drop across the resistor 28 due to the flow of plate current is of opposite polarity to the voltage across that portion of the voltage divider 21 between the negative terminal and ground. The relative values of these voltages are made such that with no signal impressed upon the receiver the cathode 6 is a few volts positive (5 volts, for example) above ground.

The circuit described up to this point would function to provide automatic volume control in the following manner: Until the incoming signal reached a certain predetermined strength, the cathode 6 would be positive with respect to ground and the grids of the intermediate frequency amplifier tubes would be maintained slightly positive whereby the gain of the amplifier would be a maximum, but with the result that the tubes might be injured after a certain period. As the incoming signal increases in amplitude the direct current component through resistor 16 increases to make grid 9 more negative and the plate current flowing through the cathode resistor 28 decreases whereby the cathode 6 finally comes to ground potential and then becomes increasingly negative. Of course the more negative the cathode 6 becomes, the greater is the negative bias applied to the I. F. amplifier tubes and the greater is the reduction in gain.

The grids of the intermediate frequency amplifier tubes are prevented from going positive by employing a rectifier such as a diode in the automatic volume control circuit. This diode preferably is included in the tube 3 which includes an indirectly heated cathode 34, a diode plate 36, a control grid 37, and an anode 38. The diode plate 36 is connected through a conductor 39 to the lower end of the resistor 31. Preferably the cathode 34 is connected through a conductor 41 to a negative point 42 on the voltage divider 21.

The circuit now operates as follows: When the incoming signals are below a predetermined value the cathode 6 is positive wtih respect to ground, as previously explained, whereby positive potential is applied to the diode plate 36. As a result there is a flow of current through the diode 34—36, this current flowing through a circuit which may be traced from the cathode 6 through the resistor 31, the conductor 39, the diode 34—36, the conductor 41, the left hand section of the voltage divider 21 and back to the cathode 6 through the cathode resistor 28. It will be apparent that by properly adjusting the circuit, the lower end of the resistor 31 may be made negative during this period since this end is at the same negative potential as the point 42 on the voltage divider except for the voltage drop across the diode 34—36. In accordance with my invention the circuit is so adjusted that the grids of the intermediate frequency amplifier tubes are biased negatively even when there is no incoming signal. Therefore, if the receiver is left connected to the power supply when no signal is being received, injury to the amplifier tubes is prevented.

While I have shown the cathode 34 connected to a negative point on the voltage divider 21 it should be understood that the cathode may be connected directly to ground. Such a connection will prevent the grids of the intermediate frequency amplifier tubes from going positive any appreciable amount.

In Figure 2 I have shown slight variation of the circuit shown in Figure 1. In the two figures, like parts are indicated by the same reference numerals.

One difficulty was experienced with the circuit shown in Figure 1 when an electrolytic condenser was employed for the condenser 17. This difficulty resulted from the fact that in the circuit shown in Figure 1 the polarity of the cathode 6 reverses with a change in the strength of the incoming signals as previously explained. Thus the high voltage terminal of the electrolytic condenser 17 may be positive at one time and negative at another time with the result that the condenser 17 deteriorates too rapidly.

Such deterioration of an electrolytic condenser is avoided by connecting the diode plate 36 directly to the cathode 6 through conductors 39 and 43 as shown in Fig. 2. The volume control signal is supplied from the cathode end of resistor 28 to the grids of the intermediate frequency amplifiers through a filter consisting of a filter resistor 44 and filter condenser 46. In this circuit the cathode 6 may be positive a very small amount when there is no incoming signal but it will not be positive enough to permit damage to the I. F. amplifier tubes.

It may be desirable to include a filter choke 47 in the cathode lead of the tube 2 for smoothing out the plate current supply.

Deterioration of the electrolytic condenser 17 can be prevented by a different circuit connection indicated in Fig. 1. If the condenser 17, instead of being connected to ground, is connected to a point at least as positive as is the cathode 6 when there is no incoming signal, the polarity of the condenser will not reverse. One way of making such a connection is to connect the condenser 17 between the cathode 6 and the screen grid voltage supply as by moving a switch 48 from the grounded contact point to the contact point 49.

In the drawing the values of various circuit elements have been indicated in ohms and microfarads.

From the foregoing description it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire therefore that only such limitations shall be imposed thereon as are necessitated by the prior art and are set forth in the appended claims.

I claim as my invention:

1. In combination, an amplifier, the gain of which is to be controlled, an electric discharge tube having a cathode, a control grid and an anode, means for rectifying the output of said amplifier and for impressing the resulting signal and direct current component across said cathode and control grid for amplification by said tube whereby the direct current component of the plate current of said tube is decreased in response to an increase in signal strength, a power supply unit having negative and positive terminals and having an intermediate point connected to ground, said cathode being connected to said negative terminal through a cathode resistor, said anode being connected to said positive terminal through an output impedance unit, a conductive connection from a control point on said cathode resistor to said amplifier for controlling its gain, said tube and its associated circuit being so adjusted that said control point is slightly positive when

there is no signal supplied by said amplifier, and a rectifier connected between a point on said cathode resistor having at least approximately the same potential as said control point and a point on said power supply unit which is less positive with respect to ground than said control point, said rectifier being connected in such direction that current flows therethrough when said control point is positive a certain amount with respect to ground.

2. The invention according to claim 1 characterized in that said conductive connection from the control point includes a resistor, and further characterized in that said rectifier is connected between said less positive point on the power supply unit and said last-named resistor.

3. The invention according to claim 1 characterized in that said rectifier is connected between a point on said cathode resistor and a point on said power supply unit which is negative with respect to ground.

4. In combination, an amplifier, the gain of which is to be controlled, an electric discharge tube including a pair of diode plates, an anode, a control grid, and a cathode common to said anode and said diode plates, a transformer having opposite terminals connected to said diode plates and having its midpoint connected to said cathode through a resistor to form a push-pull detector, a conductive connection from said control grid to a point on said resistor, a power supply unit having negative and positive terminals and having an intermediate point connected to ground, said cathode being connected to said negative terminal through a cathode resistor, said anode being connected to said positive terminal through an output impedance unit, a conductive connection from a control point on said cathode resistor to said amplifier for controlling its gain in accordance with the voltage drop across said cathode resistor, and a rectifier connected between a point on said cathode resistor and a point on said power supply unit which is less positive with respect to ground than said control point, said rectifier being connected in such direction that when said control point is positive a certain amount with respect to ground there is current flow through said rectifier.

5. The invention according to claim 4 characterized in that said conductive connection from the control point includes a resistor, and further characterized in that said rectifier is connected between said less positive point on the power supply unit and said last-named resistor.

6. The invention according to claim 4 characterized in that said rectifier is connected between a point on said cathode resistor and a point on said power supply unit which is negative with respect to ground.

7. In a radio receiver, an amplifier having an output circuit, a second amplifier having an input circuit including a control grid and having a plate circuit including a cathode resistor, a detector coupling said output circuit and said input circuit, said detector being so connected to said control grid that said grid becomes more negative in response to an increase in the strength of an incoming signal, a plate voltage supply unit included in said plate circuit and connected between said cathode resistor and said plate, said voltage supply unit being connected to ground at a point such that the cathode end of said cathode resistor is positive when there is no incoming signal, a connection from said cathode end to said first amplifier for supplying gain potential thereto, and a circuit including a diode connected between said cathode end and a point in said plate circuit which is less positive than the cathode end of said cathode resistor.

8. In combination, an amplifier, the gain of which is to be controlled, an electric discharge tube having a cathode, a control grid, an anode, and a diode plate, means including said diode plate and said cathode for rectifying the output of said amplifier and for impressing the resulting signal and direct current component across said cathode and control grid for amplification by said tube whereby the direct current component of the plate current of said tube is decreased in response to an increase in signal strength, said tube having a plate circuit which includes a cathode resistor and means for maintaining the cathode end of said resistor only slightly positive with respect to ground when there is no signal supplied by said amplifier, means for supplying gain control potential from said cathode end to said first amplifier, and a rectifier connected between the cathode end of said cathode resistor and a point in the circuit less positive than said cathode end.

9. In combination, an amplifier, the gain of which is to be controlled, an electric discharge tube having a cathode, a control grid, an anode, and a diode plate, means including said diode plate and said cathode for rectifying the output of said amplifier and for impressing the resulting signal and direct current component across said cathode and control grid for amplification by said tube whereby the direct current component of the plate current of said tube is decreased in response to an increase in signal strength, said tube having a plate circuit which includes a cathode resistor and means for maintaining the cathode end of said resistor only slightly positive with respect to ground when there is no signal supplied by said amplifier, means for supplying gain control potential from said cathode end to said first amplifier, another amplifier tube including a diode section and an amplifier section, the input electrodes of said amplifier section being coupled to said plate circuit, and said diode section being connected between the cathode end of said cathode resistor and a point in the circuit less positive than said cathode end.

10. The invention according to claim 8 characterized in that an electrolytic condenser is connected between the cathode of said electric discharge tube and a point in the circuit which is at ground for signal frequencies and which is at least as positive as said cathode when there is no signal supplied by said first amplifier.

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