Sept. 10, 1940. E. W. HEROLD 2,214,613

VOLUME CONTROL CIRCUITS

Filed March 23, 1939

Fig. 1

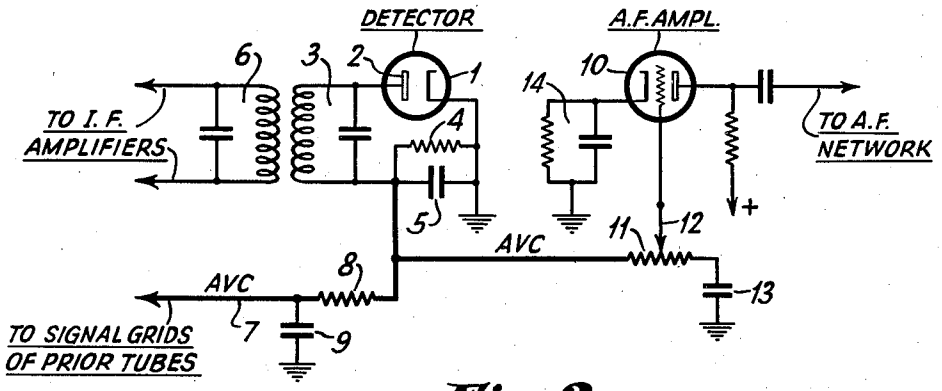


Fig. 2

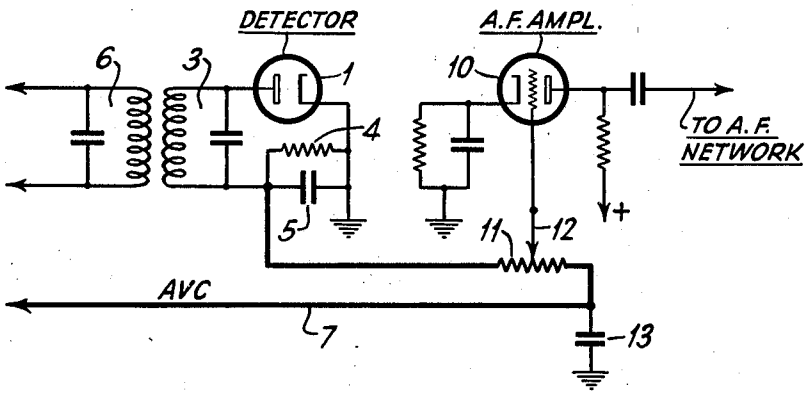
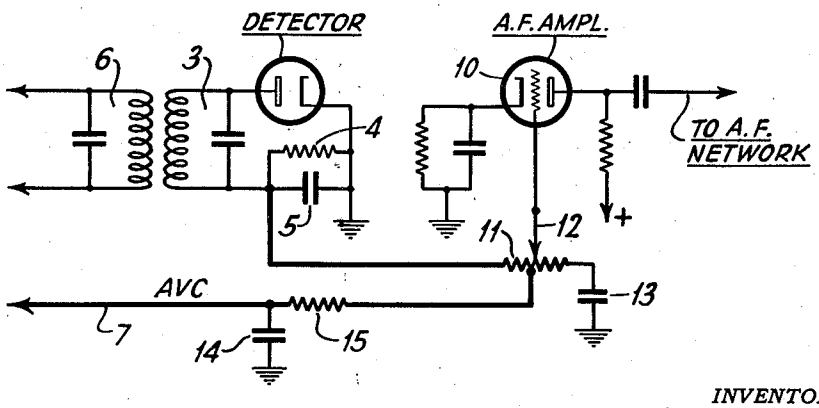


Fig. 3



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VOLUME CONTROL CIRCUITS

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8 Claims. (Cl. 250—20)

My present invention relates to volume control circuits for audio amplifiers, and more particularly to simplified gain control connections between a diode detector and a subsequent audio amplifier.

One of the important objects of my invention is to provide, in a radio receiver, a signal detector of the diode type which supplies its audio voltage output to a succeeding audio amplifier through a potentiometer; the potentiometer being so constructed that the audio amplifier signal grid has its potential varied in accordance with the direct current voltage output of the detector, and the audio signal grid being connected to the diode anode solely through the potentiometer resistor.

Another important object of this invention may be stated to reside in the provision of a diode detector which has in its output circuit a resistor-condenser network functioning simultaneously as the manual volume control device for a succeeding audio amplifier and as the filter for an automatic volume control connection to one or more preceding signal amplifiers.

Still other objects of my invention are to improve generally the simplicity, compactness and efficiency of audio coupling connections between a diode detector and a succeeding audio amplifier, and more especially to provide adjustable audio connections to diode detectors in a manner which is not only reliable and efficient in operation, but is economically manufactured and assembled in radio receivers.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawing:

Fig. 1 shows an embodiment of the present invention;

Fig. 2 illustrates a modification; and

Fig. 3 illustrates a further modification.

Referring now to the accompanying drawing, wherein like reference characters in the different figures designate similar circuit elements, there is shown in Fig. 1 the detector and audio frequency amplifier networks of a radio receiver. The receiver may be of any desired type, such as the well known superheterodyne receiver utilized in the broadcast range of 550 to 1500 k. c. The detector is of the diode type, and the diode 1 has its anode 2 connected to its grounded cathode through a path which includes in series the resonant input circuit 3 and the load impedance 4. The impedance 4 is shunted by a carrier by-pass condenser 5, and the input circuit 3 is tuned to the operating carrier frequency. If the receiver is of the superheterodyne type, then circuit 3 is tuned to the operating intermediate frequency (I. F.), and it will be understood that numeral 6 denotes the intermediate frequency output circuit of the final intermediate frequency amplifier. It is not believed necessary to explain in detail the construction of the various signal amplifier networks which may precede circuit 6, since those skilled in the art are very well acquainted with such networks.

The audio and direct current voltage components developed across impedance 4 are utilized as shown in Fig. 1. The direct current voltage component is employed automatically to regulate the gain of one or more of the preceding signal carrier amplifiers, and such automatic volume control circuit is designated by the letters "AVC." The gain control connection 7 is made to the anode end of resistive impedance 4 through a resistor 8, the resistor being connected to ground through a condenser 9. This resistor-condenser network provides the usual filter for removing pulsation voltage components from the gain control voltage.

The audio voltage component of the rectifier output voltage is utilized for subsequent audio frequency amplification. This is accomplished by providing the audio frequency amplifier 10, and the signal grid of the latter is connected to the anode end of impedance 4 through the potentiometer comprising resistor 11 and adjustable tap 12. One end of resistor 11 is connected directly to the anode end of resistor 4, while its opposite end is connected to ground through the capacitor 13. The cathode of amplifier 10 is connected to ground through the usual self-biasing network 14, and it is to be understood that the audio voltage output of amplifier 10 will be transmitted through one or more subsequent amplifiers, and finally reproduced by any desired type of audio reproducer.

It will be observed that the signal grid of amplifier 10 normally, that is in the absence of incoming carrier signals, has a negative bias applied to it through a path which includes tap 12, resistor 11, load impedance 4, ground and the biasing resistor of the audio amplifier. As soon as carrier energy is received, and the amplitude

of the carrier increases, then the signal grid of amplifier 10 has its negative bias increased. There is thus provided automatic gain regulation of both the pre-detector stages and the subsequent audio amplifier. Adjustment of tap 12 with respect to resistor 11 provides adjustment of the magnitude of the audio voltage impressed on the audio amplifier; the potentiometer 11—12, therefore, acts as a manual volume control device to regulate the loudness of audio reproduction.

The direct current voltage from the diode load impedance 4 is impressed on the signal grid of amplifier 10 directly through the potentiometer resistor 11, while the audio voltage component is attenuated by adjustment of the potentiometer tap 12. This is true because the lower end of the potentiometer resistor is effectively at alternating current ground potential through the condenser 13. This circuit is of advantage in that, under average conditions, a lower direct current resistance is obtained in the grid circuit of amplifier 10 than with other well-known arrangements which accomplish the same result. At the same time, the effects of any grid current flow in the grid circuit of amplifier 10 on the operation of the pre-detector tubes are highly minimized.

In the arrangement shown in Fig. 2 the functions of the elements in Fig. 1, and which elements are included in the audio and direct current connections to the detector, are provided with a minimum of parts. In this case the potentiometer resistor 11 and the condenser 13 function simultaneously as the manual volume control device and the automatic volume control filter network. It will be observed that in this arrangement the automatic volume control connection 7 is made to the junction of resistor 11 and condenser 13, so that the lead 7 derives the direct current voltage from the load impedance 4 through the potentiometer resistor 11. The resistor 11 and condenser 13 are chosen in magnitude so that they provide a proper suppression of pulsation voltages with the result that the control voltage transmitted over lead 7 is properly filtered. At high volume control settings of tap 12 the direct current resistance of the grid circuit of amplifier 10, which is common to the controlled pre-detector tubes, is considerably reduced so that, in this condition, any undesirable grid current flow in tube 10 has but little effect on the operation of the pre-detector tubes.

It is frequently desirable to add a bass-compensating network to the volume control circuit of Fig. 2. Fig. 3 shows a circuit incorporating such a network connected to a fixed tap on volume control 11. The network consists of a resistance 15 and capacitance 14. The AVC voltage for the pre-detector stages is taken from lead 7 which is connected to the junction of elements 14 and 15. By this means, the time constant of the AVC network is not too large, as it might be if it were connected to the junction of elements 11 and 13 of Fig. 3. The circuit of Fig. 3 has an advantage over that of Fig. 2 in that the audio volume at minimum setting of the slider 12 is considerably less, and, in fact, may be made negligibly small.

It should be understood that my invention is not limited to the specific embodiments shown in the figures. For example, it is sometimes desirable to add additional filtering of the radio frequency, or intermediate frequency, alternating voltages to that already provided by the capacitance 5. Such additional filtering between the diode detector and the audio amplifier is well known in the art, and it is unnecessary to elaborate on such a modification here. It is also understood that the potentiometer 11 may be modified to include additional taps for automatic bass compensation.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In a signal receiver, a diode detector network including a load impedance across which are developed audio and direct current voltages, an audio amplifier having a signal input grid, a path comprising a resistor and condenser in shunt to said impedance, an adjustable connection between the grid and said resistor for regulating the magnitude of the audio voltage impressed on the grid, and an automatic volume control circuit connected to the junction of said resistor and condenser.

2. In a signal receiver, a diode detector network including a load impedance across which are developed audio and direct current voltages, an audio amplifier having a signal input grid, a path comprising a resistor and condenser in shunt to said impedance, an adjustable connection between the grid and said resistor for regulating the magnitude of the audio voltage impressed on the grid, said resistor and condenser being chosen to function as a filter network for the direct voltage, and an automatic volume control circuit connected to the junction of said resistor and condenser.

3. In a radio receiver of the type comprising a diode rectifier having an input circuit adapted to be coupled to a signal amplification network, an audio amplifier provided with input and output electrodes, said rectifier including a load impedance for developing audio and direct current voltages from rectified signal currents flowing through the impedance, an automatic gain control connection to a point on said impedance which becomes increasingly negative with signal carrier amplitude increase, said connection including a filter resistor, a second gain control connection from said amplifier input electrode, said second connection including an adjustable tap slidable along said resistor to vary the magnitude of audio voltage impressed on the input electrode.

4. In a radio receiver of the type comprising a diode rectifier having an input circuit adapted to be coupled to a signal amplification network, an audio amplifier provided with input and output electrodes, said rectifier including a load impedance for developing audio and direct current voltages from rectified signal currents flowing through the impedance, an automatic gain control connection to a point on said impedance which becomes increasingly negative with signal carrier amplitude increase, said connection including a resistor, a second gain control connection from said amplifier input electrode, said second connection including an adjustable tap slidable along said resistor to vary the magnitude of audio voltage impressed on the input electrode, and a condenser in series with said resistor across said impedance, the resistor and condenser providing a filter for removing pul-

sations from the direct voltage transmitted over said automatic control connection.

5. In combination with a signal carrier receiving system including a detector and carrier gain control network, said detector having a load impedance across which is generated direct and audio voltages, an audio volume control resistor consisting of a potentiometer with an adjustable tap, a first connection from one end of said volume control resistor to a point on the detector load impedance, said first connection being adapted for the transmission of the direct current and at least part of the demodulation products which result from rectification by said detector of a received signal, a second connection from the other end of said volume control resistor through a capacitance to a second point on the detector load impedance, an amplifier system with an electron discharge tube having two input electrodes one of which is connected to the variable tap on the aforementioned volume control resistor and the other of which is connected to the said second point on the detector load impedance, and a connection from said other end of the volume control resistor to the aforementioned carrier gain control network.

6. In combination with a signal carrier receiving system including a detector and carrier gain control network, said detector having a load impedance across which is generated direct and audio voltages, an audio volume control resistor consisting of a potentiometer with an adjustable tap, a first connection from one end of said volume control resistor to a point on the detector load impedance, said first connection being adapted for the transmisison of the direct current and at least part of the demodulation products which result from rectification by said detector of a received signal, a second connection from the other end of said volume control resistor through a capacitance to a second point on the detector load impedance, an amplifier system with an electron discharge tube having two input electrodes one of which is connected to the variable tap on the aforementioned volume control resistor and the other of which is connected to the said second point on the detector load impedance, and a connection from an intermediate point on said volume control resistor to a frequency discriminating network including a second capacitance, one end of which is connected to said other end of the volume control resistor and the other end of which is connected to the aforementioned carrier gain control network.

7. In combination with a signal carrier receiving system including a detector and carrier gain control network, said detector having a load impedance across which is generated direct and audio voltages, an audio volume control resistor consisting of a potentiometer with an adjustable tap, a first connection from one end of said volume control resistor to a point on the detector load impedance, said first connection being adapted for the transmission of the direct current and at least part of the demodulation products which result from rectification by said detector of a received signal, a second connection from the other end of said volume control resistor through a capacitance to a second point on the detector load impedance, an amplifier system with an electron discharge tube having two input electrodes one of which is connected to the variable tap on the aforementioned volume control resistor and the other of which is connected to the said second point on the detector load impedance, and a connection from an intermediate point on said volume control resistor to one end of a resistance whose other end is connected to both the aforementioned carrier gain control network and to one side of a second capacitance, said second capacitance having its other side connected to said second point on the detector load impedance.

8. In combination with a signal carrier receiving system including a detector and carrier gain control network, said detector having a load impedance across which is generated direct and audio voltages, an audio volume control resistor consisting of a potentiometer with an adjustable tap, a first connection from one end of said volume control resistor to a point on the detector load impedance, said first connection being adapted for the transmission of the direct current and at least part of the demodulation products which result from rectification by said detector of a received signal, a second connection from the other end of said volume control resistor through a capacitance to a second point on the detector load impedance, an amplifier system with an electron discharge tube having two input electrodes one of which is connected to the variable tap on the aforementioned volume control resistor and the other of which is connected to the said second point on the detector load impedance, and connections from at least one intermediate point on said volume control resistor to a frequency discriminating network, which is also adapted for connection to the aforesaid carrier gain control network.

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