March 26, 1940. J. L. GETAZ 2,194,935

RADIO VOLUME CONTROL

Original Filed May 9, 1936

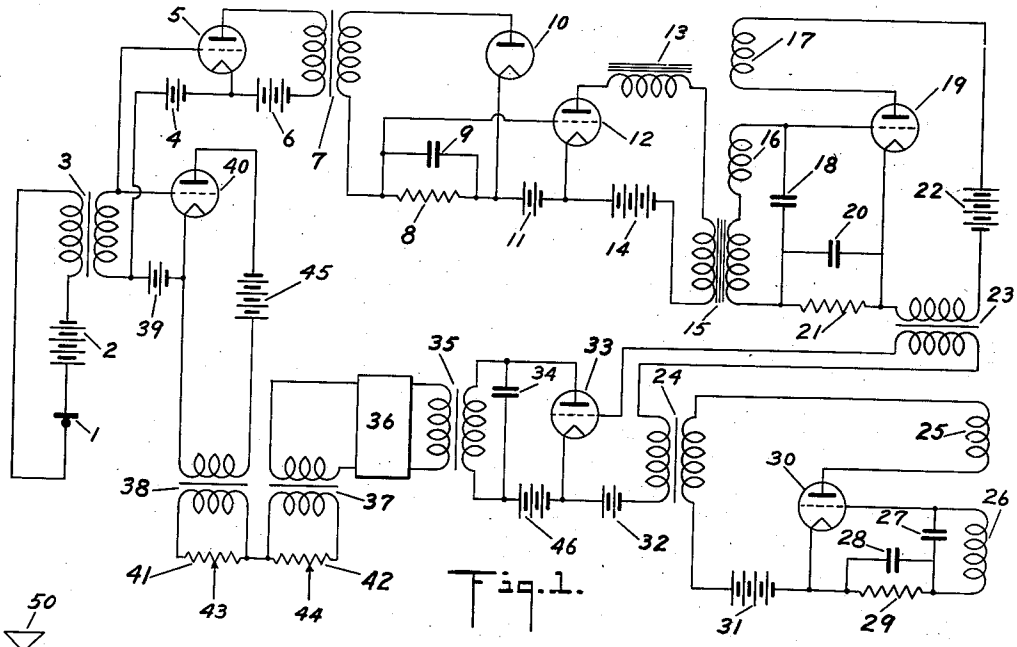


Fig. 1.

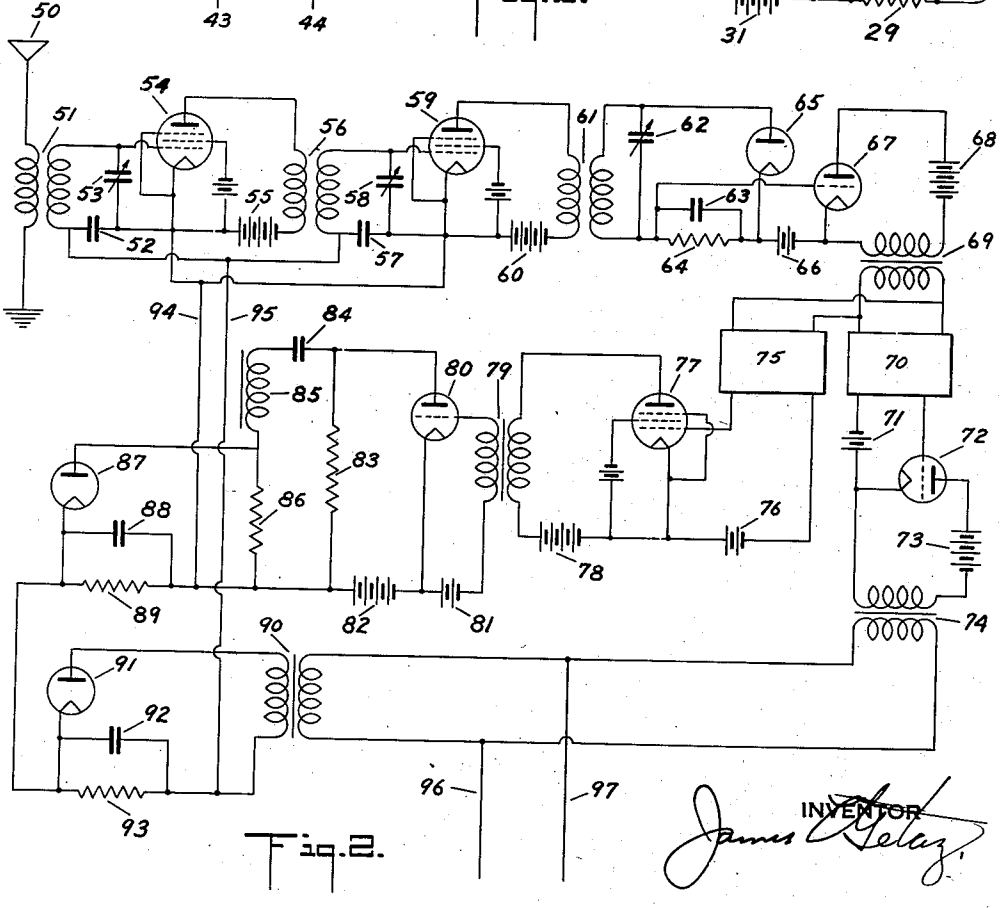


Fig. 2.

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RADIO VOLUME CONTROL

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This invention relates to the electrical transmission of intelligence signals, such as sound signals and particularly to the control of the volume of the sound received.

The purposes of this invention are as follows:

1. To control this volume of sound as received so that it will be independent of the strength of the received signal.

2. To control this volume of sound as received so that it will be independent of contractions in volume which may be made at the transmitting station by the transmitting operator.

3. To control the volume of sound as received so that the receiving set will have small amplification when no signal is being received.

4. To automatically maintain the same volume of sound received in changing from one transmitting station to another station of different strength.

5. To provide means for controlling the volume of sound at the receiving set so that the volume of sound as received will be proportional to the volume of sound as originally produced.

In Fig. 1 is shown diagrammatically the connections to provide for such control at the broadcasting station.

In Fig. 2 is shown the connections for the receiving set.

The basic principle involved in obtaining such volume control is to utilize an arrow band of frequency, and at the transmitting station to generate waves within this band so that the frequency of the waves will vary with the volume of the sound produced. These waves constitute signals denoting the volume of the original sound and are used in radio transmission to modulate the carrier wave, and may be referred to as volume signals. The carrier is thus modulated in two ways, it contains the regular modulation which corresponds in frequency and amplitude with the original sound, and in addition it carries another modulation consisting of these volume signals. In the transmitting wave, the amplitude of these volume signals is not of particular importance, except that they should produce a fair amount of modulation. Their usefulness depends on the variations of their frequency, and we thus have along with the usual signals, a special band of signals representing volume by frequency rather than by amplitude.

The principles of this invention may be applied to any means for the transmission or reproduction of sound in which electrical signals are used to represent the sound waves. These principles may be used for controlling the amplification of electrical signals representing sound waves which are reproduced from phonograph records or motion picture films.

To avoid distortion of the regular signals, these volume signals may be confined to a band below audible frequency, from a fraction of one cycle per second to about twenty-five cycles.

In Fig. 1 the microphone 1 is supplied with current by the battery 2 and is connected by the transformer 3 to the amplifying circuit consisting of the battery 39, the triode 40 and the battery 45, this circuit includes the transformer 38 which connects to the transmitter modulator through the line 43.

This transformer 3 is also connected to the amplifying circuit consisting of the battery 4, the battery 6, the triode 5, and the transformer 7. The current from the transformer 7 is rectified by the diode 10, thus producing a direct current envelope which corresponds with the variation in volume of the current generated in the microphone circuit. In the circuit of this diode 10 is a resistance 8 shunted by a condenser 9, and the ends of this resistance are connected to the grid and filament of the triode 12. By varying resistance 8 and the capacity of the condenser 9 it is possible to control the frequency with which the rectifier will follow the volume change. The circuit of this triode 12 amplifies the voltage variations in the envelope produced by the diode 10, and this circuit contains the battery 11, the battery 14, the choke coil 13, and the saturation reactor 15. This saturation reactor is connected in the circuit of the oscillating tube 19, which consists of the feed back coils 16 and 17, the condenser 18, the battery 22 and the resistance 21 which is by-passed by the condenser 20. This oscillating circuit is adjusted to produce oscillations of medium frequency, the frequency of these oscillations are varied by the saturation reactor 15, and are transmitted to the grid of the triode 33 by connections to the transformer 23.

Another oscillating circuit consists of the triode 30, the feed back coils 25 and 26, the condenser 27, the battery 31 and the resistance 29, which is by-passed by the condenser 28. The circuit is adjusted to produce oscillations of about the same frequency as those produced by the tube 19 and is connected to the grid of the triode 33 by the transformer 24. This circuit maintains a constant frequency.

The frequency of the beats between these two oscillating circuits varies as the frequency of the oscillations, produced by tube 19, is varied by the saturation reactor 15. By proper adjustment of

the two oscillating circuits the frequency of these beats may be made to vary inversely with the amplitude of the direct current envelope and they may be confined to a narrow band below the audible frequency. The oscillations of these two circuits are rectified by triode **33** in the circuit consisting of the battery **32**, the battery **46** and the condenser **34**, and the beats are transmitted through the transformer **35** and the low pass filter **36**, which filters out any harmonics. These low frequency beats are connected through the transformer **37** to the line **44** leading to the transmitter modulator. The connection **44** is set on the resistance **42** to fix the amplitude of the volume signals, and the line **43** may be varied in its connection to the resistance **41**, so as to vary the modulation of the main signals. This variation does not affect the modulation which is made by the volume signals.

In Fig. 2 the signals are received from the antenna **50** through the transformer **51** and are amplified in two or more circuits consisting of the pentode **54**, the battery **55**, the condenser **52** and the tuning condenser **53**, and transformer **56**, also the pentode **59**, battery **60**, condenser **57**, tuning condenser **58**, and transformer **61**. These signals are rectified by the diode **65**, in the circuit containing the tuning condenser **62**, the resistance **64**, which is by-passed by the condenser **63**. The audio frequency is amplified in the circuit containing the triode **67**, the battery **68**, the battery **66**, and the transformer **69**. From the transformer **69**, the main signals pass through the high pass filter **70** which admits all frequencies in the audible range. The frequencies below the audible range which constitute the volume signals, mentioned above, pass through the low pass filter **75** which does not admit the frequencies in the audible range.

The main signals after passing through the filter **70** are further amplified in the circuit containing the triode **72**, the battery **73**, battery **71** and transformer **74** and from thence to the loud speaker through the lines **96** and **97**.

The volume signals after passing through the low pass filter **75** are amplified in the circuit consisting of the pentode **77**, battery **78**, battery **76** and transformer **79**. This pentode **77** is charged with a low plate voltage low screen voltage and a high grid signal voltage so that the amplification is always in excess of the capacity of the tube. Additional amplification circuits may be included between the pentode **77** and the low pass filter **75**, or regenerative amplification may be used to amplify the volume signals to tube capacity. This enables the tube to maintain an output of constant amplitude irrespective of the amplitude of the volume signal, provided volume signals are being transmitted by the broadcasting station.

From the transformer **79**, these volume signals pass through a corrector circuit consisting of the triode **80**, battery **81**, battery **82**, resistance **83**, condenser **84**, inductance **85**, and resistance **86**. The condenser **84** is of sufficient capacity to transmit the volume signals of lowest frequency. This circuit varies the drop in voltage across the resistance **86** inversely to the frequency of the volume signals. The higher frequencies are choked by the impedance of the coil **85** and are divided between this coil and the resistance **83**, the lower the frequency a larger proportion of the current passes through the coil **85** and the resistance **86**. Connected across the resistance **86** is a rectifying circuit consisting of the diode **87**, resistance **89**, which is by-passed by the condenser **88**. The rectification of these low frequency signals produces an envelope in which the amplitude varies with the frequency of the volume signals.

In a similar manner the audio signals from the transformer **74** are rectified in the circuit containing the diode **91**, and resistance **93**, which is by-passed by the condenser **92**. This produces an envelope the amplitude of which varies with the voltage of the audio signals, these signals being transmitted to the loud speaker by the lines **96** and **97**.

The envelope produced by the diode **91** varies in amplitude with the amplitude of the signals as actually received.

The envelope produced by the diode **87** varies inversely as the frequency of the volume signals sent out by the broadcasting station. If the circuits are properly adjusted the two envelopes should be practically the same in amplitude at all times. The positive ends of the resistances **89** and **93** are connected to each other. The negative end of resistance **89** is connected by the wire **94** to the filaments of pentodes **54** and **59**. The negative end of resistance **93** is connected by the wire **95** to the grids of the pentodes **54** and **59**. By these connections the drop in voltage across the resistor **89** is compared with the drop in voltage across the resistor **93**. The drop in voltage across the resistor **89** varies with the varying voltage of the envelope in that circuit and is representative of the strength of signals as transmitted. The drop in voltage across the resistor **93** varies with the varying voltage of the envelope in that circuit and is representative of the strength of the signals as received. If the envelope of the signals as actually received has greater amplitude than the envelope of the volume signals, the grids of the pentodes **54** and **59** will be made more negative by the connection to the negative side of resistance **93** and the volume of the received signals will be reduced until the amplitude of the two envelopes are equal.

If the envelope of the volume signals as produced by the diode **87** is greater than the envelope of the signals actually received, the filaments of the pentodes **54** and **59** will be made more negative with reference to the grids, which increases the grid voltage and increases the volume of the received signals until the envelopes are equal.

The operation of these circuits may be summarized as follows: In the transmitting set the signals are amplified and then rectified in the diode **10** so as to produce an envelope, not of the signal itself but of its amplitude.

This direct current which varies with volume of sound to be transmitted is used to vary the frequency of the oscillating tube **19**. The oscillations of this circuit are combined with the oscillations on the circuit of triode **30**, in which the oscillations are constant. The beats of these two oscillating circuits are rectified in the circuit of the triode **33**, passed through the low pass filter **36** and connected to the transmitter modulator. The beats of these circuits are of such low frequency as to not be audible, or interfere with the modulation of the carrier for transmission of the regular signals.

In the receiving set after the signals have been amplified and detected in the usual manner, the audio frequencies are divided, the audible frequencies passing through the filter **70** and after further amplification to the loud speaker. The

audio frequencies below the audible range are the volume signals, these are amplified in a tube 77 which is overloaded so that the amplitude of these signals is not proportional to the strength of the signals received but is fixed by the capacity of the tube.

These volume signals are then passed through the corrector circuit of the triode 80 by which their amplitude is made inversely proportional to their frequency, and they are then rectified in the circuit of the diode 87 as mentioned above. The voltage of this circuit forms the standard by which the volume is to be controlled. By connecting lines 94 and 95 to the grids and filaments of several stages of amplification, a close regulation of volume may be automatically obtained in tuning from one station to another, if these stations are provided with volume signals. As mentioned on page 1, a purpose of this invention is to make the volume of the sound received proportional to the sound transmitted. It includes means for correcting distortion in volume from all causes in electrical transmission and reception, such distortion as is caused by the curvature of the grid voltage, plate current curve of the tubes used in audio frequency amplification. It also includes means for limiting the noise received, so that the volume of the noise plus the volume of the signal received would be equal to what the volume of the signal should be if noise were not being received.

This invention is shown and described as referring to the transmission and reproduction of electrical signals which represent sound signals. It is apparent that it may be applied to electrical signals which represent other forms of intelligence signals besides sound, and it is intended to include the control of electrical signals which are used to transmit intelligence in any form.

I claim:

1. In an electrical receiving set, means for receiving a carrier wave, means for receiving intelligence signals by demodulating said carrier wave, means for receiving signals which indicate the volume of the sound being transmitted and means for comparing an intensity derived from said intelligence signals as received with the volume of sound transmitted as indicated by said volume signals, means for using said comparison for correcting the rate of amplification of said intelligence signals.

2. In an electrical receiving set, means for receiving signals which vary in frequency with the volume of sound transmitted, means for producing an envelope derived from said volume signals which varies in amplitude in proportion to their frequency, means for receiving sound signals, means for producing an envelope derived from said sound signals which varies in amplitude in proportion to the amplitude of said sound signals, means for utilizing the voltage of these two envelope currents to regulate the volume of sound produced.

3. The method of receiving signal energy from a carrier medium modulated with electrical signals and an additional modulating current, which comprises, deriving the electrical signals from said carrier medium, deriving said additional modulating current from said carrier medium, comparing the strength of said signals with the strength of the signals transmitted as represented by said additional modulating current, and controlling the degree of amplification of said signals by a voltage which corresponds to the difference between the strength of said signals as received and the strength of said signals, when transmitted, as represented by said additional modulating current.

4. The steps in a method of deriving signal energy from a carrier medium modulated with electrical signals and an additional modulating current which comprise, deriving from said carrier medium said electrical signals, deriving from the carrier medium said additional modulating current, amplifying said modulating current to a fixed amplitude, amplifying said modulating current to produce a difference of potential which varies in accordance with the variations of frequency of said modulating current, rectifying said differences of potential, rectifying said electrical signals, using the comparative strength of said rectified difference of potential and said rectified signals to control the degrees of amplification of said signals.

5. In an electrical receiving set, means for receiving sound signals, means for receiving control signals which represent by their frequency the volume of the sound being transmitted, means for rectifying said control signals, means for obtaining potentials from said control signals which vary with their frequency, means for amplifying said sound signals, means for regulating said amplification by said potentials, means for rectifying said sound signals and obtaining potentials representing their amplitude, means for comparing the potentials representing the volume of said amplified signals with the potential representing the volume of sound transmitted as represented by said control signals.

6. In an electrical receiving set, means for receiving a carrier wave modulated with sound signals, means for deriving sound signals from said carrier wave, means for amplifying said sound signals, means for obtaining a voltage proportional to the volume of said amplified sound signals, means for deriving control signals of variable frequency from said carrier wave, means for obtaining a voltage which varies with the frequency of said control signals, means for controlling said amplification by the difference between said voltages.

7. In an electrical receiving set, means for receiving a carrier wave of constant frequency containing sound signals and also signals representing the volume of sound transmitted, means for deriving sound signals from said carrier wave, means for deriving potentials from said carrier wave which represent the volume of sound being transmitted, means for comparing the potentials representing the volume of sound as received with the potentials representing the volume of sound transmitted as indicated by said volume signals, means for using said comparison for controlling the amplification of said carrier.

8. In an electrical receiving set, means for receiving a carrier wave modulated with sound signals, means for deriving sound signals from said carrier wave which vary in frequency over the whole audio-frequency band, means for amplifying said sound signals in said receiving set at all of said frequencies, means for deriving volume signals from said carrier wave which represent the volume of sound being transmitted, means for comparing the potentials representing the volume of said sound signals as amplified at all audio frequencies, with the potentials representing the volume of sound being transmitted as indicated by said volume signals, means for using said comparison to control the rate of amplification of said sound signals.

9. In an electrical receiving set, means for receiving signals which represent the volume of the sound being transmitted, means for amplifying said signals to a constant amplitude, and means for comparing the potentials representing the volume of sound as received with the potentials representing the volume of sound transmitted as indicated by said signals, means for using said comparison to control the volume of sound received.

10. In an electrical receiving set, means for receiving a carrier wave containing control signals and intelligence signals, means for rectifying said carrier wave, means for deriving intelligence signals from the modulation of said carrier wave, means for amplifying said intelligence signals, means for obtaining a voltage representative of the amplitude of said intelligence signals, means for comparing said representative voltage with a voltage derived from said control signals, and means for utilizing the difference between said voltages to increase and decrease amplification of said signals.

11. In an electrical receiving set, means for receiving a carrier wave which is modulated with a frequency control and with sound signals, means for rectifying said carrier wave, means for deriving signals from the modulation of said carrier wave, means for amplifying said signals, means for obtaining a voltage representative of the amplitude of said signals, means for comparing said representative voltage with a voltage to which it is desired for the signals to be amplified, and means for regulating the amplification of said signals, so that their voltage will correspond with said desired voltage.

12. In an electrical receiving set, means for receiving a carrier wave which is modulated with a frequency control and with sound signals, means for rectifying said carrier wave, means for deriving sound signals from the modulation of said carrier wave, means for amplifying said signals, means for obtaining a voltage representative of the amplitude of said signals, means for comparing said representative voltage with a voltage derived from said frequency control to which it is desired for said signals to be amplified, and automatic means for increasing the amplification of said signals when said representative voltage is less than said desired voltage.

13. In an electrical receiving set, means for receiving a carrier wave of substantially constant frequency which contains intelligence signals and volume control signals, means for deriving said control signals from said carrier, means for deriving said intelligence signals from said carrier, means for utilizing said control signals in combination with said intelligence signals to control the rate of amplification of said carrier.

14. In an electrical receiving set, means for receiving intelligence signals and control signals which indicate by their frequency the volume of the intelligence signals transmitted, means for obtaining potentials representing the amplitude of said intelligence signals, means for obtaining potentials representing the frequency of said control signals, means for controlling the rate of amplification of said intelligence signals by the combined action of said potentials.

15. In an electrical receiving set, means for receiving a carrier wave of substantially constant frequency which contains intelligence signals and control signals which indicate by their frequency the volume of the intelligence signals transmitted, means for obtaining potentials representing the amplitude of said intelligence signals, means for obtaining potentials representing the frequency of said control signals, means for controlling the rate of amplification of said carrier by the combined action of said potentials.

16. In an electrical receiving set, means for receiving a carrier wave of substantially constant frequency which contains intelligence signals and control signals which indicate by their frequency the volume of the intelligence signals transmitted, means for obtaining potentials representing the amplitude of said intelligence signals, means for obtaining potentials representing the frequency of said control signals, means for controlling the rate of amplification of said carrier by the difference between said potentials.

17. The steps in receiving a carrier wave of substantially constant frequency, modulated with intelligence signals, and modulated with control signals of variable frequency, which comprise, deriving said intelligence signals from said carrier, obtaining potentials representing the amplitude of said intelligence signals, deriving said control signals from said carrier, obtaining potentials representing the frequency of said control signals, regulating the rate of amplification of said carrier by the combined action of said potentials.

18. The steps in receiving a carrier wave of substantially constant frequency, modulated with intelligence signals and control signals of variable frequency, which comprise, deriving said intelligence signals from said carrier, obtaining potentials representing the amplitude of said intelligence signals, deriving said control signals from said carrier, obtaining potentials representing the frequency of said control signals, regulating the rate of amplification of said intelligence signals by the combined action of said potentials.

19. The steps in receiving a carrier wave of substantially constant frequency modulated with intelligence signals, and modulated with control signals of variable frequency, which comprise, deriving said control signals from said carrier, amplifying said control signals to a constant amplitude, obtaining potentials which represent the frequency of said control signals obtaining potentials representing the amplitude of said intelligence signals, regulating the rate of amplification of said intelligence signals by the difference between said potentials.

20. A method of receiving and amplifying electrical signals which comprises, receiving intelligence signals, receiving control signals which indicate by their frequency the volume of the intelligence signals transmitted, obtaining potentials representing the amplitude of said intelligence signals, obtaining potentials representing the frequency of said control signals, controlling the rate of amplification of said intelligence signals by the combined action of said potentials.

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