

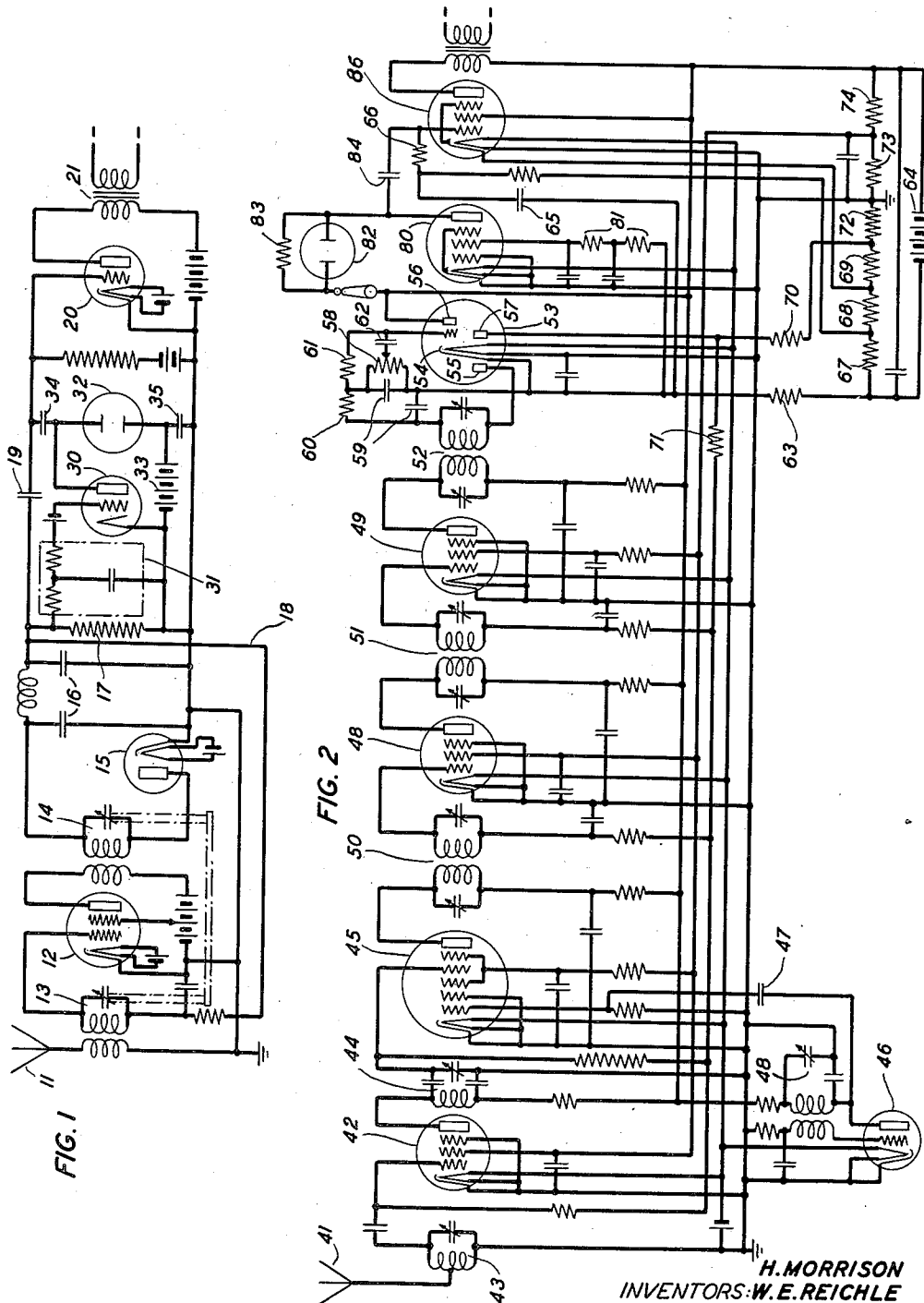
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RADIO RECEIVER

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RADIO RECEIVER

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This invention relates to radio receivers and particularly to receivers employing automatic volume control.

When automatic volume control is employed, the sensitivity of a radio receiver is inversely proportional to the amplitude of the received carrier wave. As a result, when no carrier is received, for example during silent periods in cut carrier operation or when changing the tuning of a variably tuned set, the sensitivity of the receiver is a maximum and disturbances, such as static and circuit noise, will produce an objectionable output.

An object of the invention is to provide a simple, inexpensive and efficient means for reducing the noise output during intervals when no carrier is being received by radio receivers employing automatic volume control.

In a preferred embodiment of the invention in a radio receiver employing automatic volume control, a gas-filled tube which has a low impedance at audio-frequencies when ionized and a high impedance otherwise is included in the output circuit of the receiver and a circuit connection is provided so that the voltage impressed on the tube and consequently its ionization condition is controlled by the presence or absence of a carrier input to the receiver. In this way the gas tube will effectively block the output of the receiver when no carrier is being received. To accomplish this the gas tube which is preferably of the cold cathode type is connected as an alternating current attenuating impedance in the audio-frequency path of the receiver, for example by connecting it in shunt to the grid-cathode circuit of an audio-frequency amplifier stage. The gas tube is also connected in the space current path of a triode control tube in series with the source of space current. The grid of the triode control tube has impressed thereon a voltage which is proportional to the received carrier wave which is obtained, for example from the automatic volume control rectifier. In the presence of a received wave the grid of the triode control tube is negative and the plate impedance is high so that the greater part of the voltage of the space current is absorbed in the space path of the triode control tube and insufficient voltage is available across the gas discharge tube to ignite it. Under this condition the alternating current impedance of the gas tube is very high and its effect on the audio-frequency circuit is negligible. In the absence of a received wave, the negative voltage on the grid of the triode control tube produced by the received carrier is removed and the space path impedance is

thereby reduced so that sufficient voltage appears across the gas tube to ignite it. In such a condition the alternating current impedance of the gas tube is very low, of the order of ten to a hundred ohms for commercial tubes, and because of the connection of the tube it will act as a low impedance shunt across the audio-frequency circuit greatly attenuating and practically blocking the output of the receiver.

As an alternative the gas discharge tube may be connected as a series element in the audio-frequency circuit, in which case the control voltage on the grid of the triode control tube would be such as to ignite the discharge of the gas tube in the presence of a received wave and extinguish it in its absence.

The invention may be more readily understood by reference to the following detailed description in connection with the drawing in which:

Figs. 1 and 2 show schematically two embodiments of the invention in radio receivers;

Fig. 1 shows a simplified schematic of a radio receiver embodying the essentials of the invention. In this circuit the radio signals received in the antenna 11 are supplied through the tuned circuit 13 to the input of the radio amplifier tube 12 and after being amplified are supplied through the tuned circuit 14 to the diode detector tube 15. The carrier or radio frequency components of the output of the diode detector tube 15 are filtered out by means of the low-pass filter 16 and the direct and audio-frequency components of the output are developed across the resistor 17. The direct current components of this output are fed by means of the connection 18 to the grid of the tube 12 to control the bias and consequently the amplification produced by that tube for the purpose of automatic volume control as it is well understood in the art. The audio-frequency components of the output of the detector as developed across resistor 17 are fed through the direct current blocking condenser 19 to the input of the audio-frequency amplifier tube 20 where they are amplified and the output fed through the audio-frequency transformer 21 to the headset, loudspeaker or other indicating apparatus. In this respect the radio receiver of Fig. 1 is typical of the conventional features of radio receivers well-known in the art.

With a radio receiver of this type, that is, employing automatic volume control, when the tuning condensers of the tuned circuits 13 and 14 are adjusted so that no carrier is being received, or when the receiver is employed in systems in which the transmitter radiates carrier power only dur-

ing the period of signal transmission, the absence of a received carrier will cause the automatic volume control circuit to bring the gain of the radio frequency amplifier tube 12 to a maximum. As a result, noise or other disturbing currents will be amplified to the full capacity of the receiver and may produce annoying disturbances in the audio output.

In order to avoid such effects there is employed in accordance with a feature of this invention a circuit which operates in response to the presence or absence of the received carrier so that the audio-frequency output will be reduced and effectively blocked in the absence of a received carrier.

For this purpose the direct current voltage developed across resistor 17 is supplied to the grid of a vacuum tube amplifier 30 through a resistance-capacity filter 31 which may or may not be used as will be explained in detail hereinafter. In the plate circuit of the tube 30 there is connected in series, a gaseous discharge tube 32 of the neon or similar type preferably having a cold cathode and a battery 33 for supplying space current. The electrodes of the gaseous discharge tube 32 are also connected through the direct current blocking condensers 34 and 35 to the grid and cathode of the audio-frequency amplifier tube 20. These in series with the gaseous discharge tube 32 form a shunt across the input to the audio-frequency amplifier.

The operation of the circuit is as follows: When no carrier current is being received in the antenna 11, there will be no voltage produced across the resistance 17. Consequently tube 30 will be conductive and in the series circuit including the space path of the amplifier tube 30 and the gaseous discharge tube 32 the greater portion of the voltage of the battery 33 will appear across the gaseous discharge tube 32. This voltage being sufficiently high to ignite the gaseous discharge of the tube 32 will cause the tube to discharge in which condition, as is well known, its impedance is very low. The tube 32 (in series with the condensers 34 and 35) therefore acts as a low impedance shunt across the grid to cathode circuit of the audio-frequency amplifier tube 20 for audio-frequency currents so that the audio-frequency output of the receiver is substantially blocked. On the other hand, in the presence of a received carrier there is developed a direct current voltage across the resistance 17 which is impressed between the grid and cathode of the tube 30 to make the grid negative with respect to the cathode and consequently to increase the anode to cathode impedance of the tube 30 so that the greater portion of the voltage of the battery 33 is absorbed in the space path of the tube 30 and the voltage available across the electrodes of the neon tube 32 will be insufficient to ignite or maintain the discharge thereof. Under this condition the impedance of the gaseous discharge tube 32 to audio-frequency currents is high and substantially infinite, so that the effect of the shunt circuit including the condensers 34 and 35 and the tube 32 across the input to the audio-frequency amplifier is negligible, and the receiver acts as though they were not present in the circuit.

The resistance-capacity filter 31 is provided for preventing false operation of the control circuit by noise or static disturbances of high magnitude. Such disturbances are usually of

an interrupted character while the carrier current which it is desired will be effective in operating the control circuit to establish a normal receiving condition of the radio receiver, are of a continuous nature. It is possible to distinguish between the two types of currents by means of the resistance-capacity filter so that the control tube 30 will be responsive only to continuous carrier current. This feature, namely, the use of the filter 31, is particularly desirable where there are very likely to be disturbing waves of a high amplitude, such as for example in radio receivers used in automobiles or in the neighborhood of other internal combustion engines where the ignition circuits often produce high amplitude noise currents.

To an extent the operation of the circuit is marginal in character and the constants of the tube 30 and the grid and plate voltages used should be so chosen that the discharge of the gas tube 32 will be ignited in the presence of a received carrier wave but not by background noise.

Fig. 2 shows a superheterodyne radio receiver embodying the invention. In this circuit the radio waves received from the antenna 41 are selectively amplified by the radio frequency amplifier tube 42 which is provided with tuned circuits 43 and 44 in the input and output, respectively, for selecting the desired wave. The amplified selected waves in the tuned circuit 44 are supplied to one grid of the multi-grid tube 45 which operates as a high frequency detector or modulator for combining these waves with the beating waves produced by the oscillator tube 46 and applied to another grid of the tube 45 through the coupling condenser 47, the tuned circuit 48 providing means for controlling the frequency of the waves produced by the oscillator tube 46. The intermediate frequency wave produced by the combination of the received radio waves and the beating waves from tube 46 are selectively amplified in the intermediate frequency amplifier comprising the tubes 48 and 49 and intermediate frequency filter circuits 50, 51 and 52.

The vacuum tube 53 is a multi-function tube employing a common cathode 54. This tube performs the functions of detector, direct current amplifier for automatic volume control and audio frequency and control diode for automatic volume control. The output of the last intermediate frequency filter 52 is supplied to the anode 55 of the tube 53 which operates in connection with the cathode 54 as a diode rectifier or detector for the intermediate frequency waves. The direct current and audio-frequency components of the detected currents are developed across the resistor 58, the radio frequency components being substantially eliminated by the filter comprising condensers 59 and resistance 60.

The grid of the triode section 56 of the tube 53 is connected through the resistance 61 to one terminal of the resistance 58 so that the direct and audio-frequency voltage developed across the resistance 58 will be amplified by the triode section 56. A condenser 62 with a variable tap to the resistor 58 provides means for controlling the audio-frequency voltage supplied to the grid of the triode section 56 so that the sensitivity of the receiver, that is, the audio-frequency output, may be regulated by controlling the position of the connection to the resistor 58. The output of the direct current amplifier triode sec-

tion 56 is developed across the resistor 63 which is included in the anode circuit in series with the plate current source 64. The audio-frequency components of the voltage developed across the resistor 63 are supplied to the grid of the audio-frequency amplifier tube 64 through the blocking condenser 65 and the resistor 66.

The resistor 63 is also included in series with the resistors 67, 68, 69 and 70 between the cathode and diode-anode 57 of the tube 53 for the purpose of producing an automatic volume control voltage across the resistor 70. This voltage is supplied through resistor 71 and individual filter resistors to the control grids of the tubes 42, 45, 48 and 49 for the purpose of automatic volume control. The voltage drop across the resistors 67, 68 and 69 produced by the current flow therein from the battery 64 supplies a positive voltage to the anode 57 with respect to the cathode 54, as will be described in detail hereinafter.

The resistors 67, 68 and 69 in connection with the resistors 72, 73 and 74 form a voltage dividing resistance network across the battery 64 for producing the necessary biasing voltages for the electrodes of the tubes used in the receiver.

A vacuum tube 80 which is of the high mu type is provided for the control circuit. This tube has its control grid connected through the resistance-capacity filter 81 to the terminal of the resistor 53 connected to the cathode 54. The anode circuit of the tube 80 includes in series a gaseous discharge tube 82 of the neon or similar type shunted by a resistance 83 connected in series with the battery 64, which furnishes a source of space current, the portion of the battery voltage appearing across the resistances 73 and 74 being utilized for this purpose. A connection from the control grid of the audio-frequency amplifier tube 64 through the blocking condenser 84 also connects the gaseous discharge tube 82 in shunt to the grid-cathode circuit of the audio-frequency amplifier tube 64.

In the operation of the circuit in the absence of received carrier, a maximum plate current flows through the triode section 56 and the resistor 63. The voltage produced by this current across the resistance 63 is sufficient to overcome the voltage across the resistances 67, 68 and 69 so that the anode 57 will be negative with respect to the cathode 54 and not draw current. In the presence of received signals the voltage drop across the resistor 58 causes the grid of the triode section 56 to become negative reducing the current in and consequently the voltage across the resistor 63. As the carrier strength increases this voltage is reduced to a point at which it is equal to and then lower than the voltage across the resistances 67, 68 and 69 at which latter point the anode 57 will draw current proportional to the voltage difference through the resistor 70. The voltage produced across this resistor by this current flow is supplied to the control grids of the preceding tubes of the radio receiver for the purpose of automatic volume control. This voltage is in addition to the normal bias for these tubes produced across the resistor 72. Thus the anode 57 in cooperation with the cathode 54 and other elements of the circuit produces an automatic volume control of the delayed type.

In the operation of the carrier operated anti-noise feature of this invention, when a signal is received the voltage drop across the resistor 63 decreases as pointed out above and the control grid of the tube 80 becomes more negative with respect to its cathode due to the drop across re-

sistors 67, 68, 69 and 72. As a result the internal anode-cathode impedance of the tube 80 becomes very high, and the voltage drop across it represents a large percentage of available drop in the anode-cathode circuit. Consequently, the voltage drop across the resistor 83 is not sufficiently great to ignite the gaseous discharge tube 82. In this case, the only shunt across the input to the audio-frequency tube 64 is that of the resistor 83 which may be for example of the order of 500,000 ohms and the gaseous tube 82 in parallel which have a negligible effect for audio-frequency waves and consequently on the operation of the receiver. When no signal is being received due to the receiver being tuned off a carrier wave or to the cessation of the transmission of a carrier wave, the voltage drop across the resistor 63 increases and the control grid of the tube 83 becomes more positive with respect to its cathode due to the voltage across the resistor 63. The internal anode-cathode impedance of the tube 80 decreases and consequently the current flowing through and the voltage drop across the resistor 83 increase sufficiently to ignite the gaseous discharge tube 82. Its internal resistance then becomes small and it acts as a low resistance shunt across the grid to cathode path of the audio-frequency amplifier tube 64 so as to greatly attenuate the audio-frequency current and substantially block the radio receiver.

What is claimed is:

1. In a radio receiver, means responsive to the strength of the received signal for automatic volume control, a two-electrode gaseous discharge tube connected in the audio-frequency circuit as an attenuation element, a control tube having a cathode, anode and control element, means for producing from the space current of said control tube a voltage for igniting the discharge of said gaseous discharge tube, and means for producing from the received wave a direct current voltage, and connections for supplying said direct current voltage to the control electrode of said control tube to control the space current thereof.

2. In a radio receiver, means for rectifying the received carrier wave, means responsive to the direct current components of the rectified wave for controlling the gain of the receiver, a two-electrode gaseous discharge tube, means for connecting said gaseous discharge tube as an alternating current element in shunt to the audio-frequency circuit of said radio receiver, a control tube having a cathode, an anode and a control electrode, a resistor connected in the anode-cathode circuit of said control tube, connections for supplying the voltage drop across said resistor to the gaseous discharge tube to ignite the discharge, means for normally maintaining a space current in said control tube, and means for impressing said direct current component of the rectified wave on the control electrode of said control tube to decrease the space current so that the voltage drop across said resistor is insufficient to maintain the ignition of the discharge in said gaseous discharge tube.

3. In a radio receiver, means responsive to the strength of the received signal for automatic volume control, a two-electrode gaseous discharge tube connected in the audio-frequency circuit as an attenuation element, a control tube having a cathode, anode and control element, connections for including said gaseous discharge tube in the space current of said control tube, means for obtaining a voltage to ignite the discharge of said

gaseous discharge tube from the space current of said control tube, and means for producing from a received wave a direct current voltage, connections for supplying said direct current voltage to the control electrode of said control tube to control the space current thereof, and filter means included in said connections for discriminating between a direct current voltage produced by a received carrier wave and a direct current produced by intermittent distribution.

4. In a radio receiver, means for rectifying the received wave, means responsive to the direct current components of the rectified wave for controlling the gain of the receiver, a two-electrode gaseous discharge tube, means for connecting said gaseous discharge tube as an alternating current element in shunt to the audio-frequency circuit of said radio receiver, a control tube having a cathode, an anode and a control electrode, a resistor connected in the anode-cathode circuit of said control tube, connections for supplying the voltage drop across said resistor to the gaseous discharge tube to ignite the discharge, means for normally maintaining a space current in said control tube, and means for impressing said direct current component of the rectified wave on the control electrode of said control tube to decrease the space current so that the voltage drop across

said resistor is insufficient to maintain the ignition of the discharge in said gaseous discharge tube, said last-mentioned means including a resistance-capacity filter.

5. In a radio receiver, means responsive to the strength of the received signal for automatically controlling the volume of the signal output, a two-electrode glow discharge tube connected in shunt to the signal output circuit, a control vacuum tube having a cathode, an anode and a control element, means for producing from the space current of said control tube a voltage for igniting the discharge of said glow discharge tube, means for producing from the received wave a direct current voltage, and connections for supplying said direct current voltage to the control electrode of said control tube to control the space current thereof so that in the presence of a received signal the space current will be so reduced as to extinguish the discharge of said glow discharge tube, said connections including a resistance-capacity filter of such constants as to exclude direct current resulting from intermittent noise or static disturbances as distinguished from continuous signals.

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