

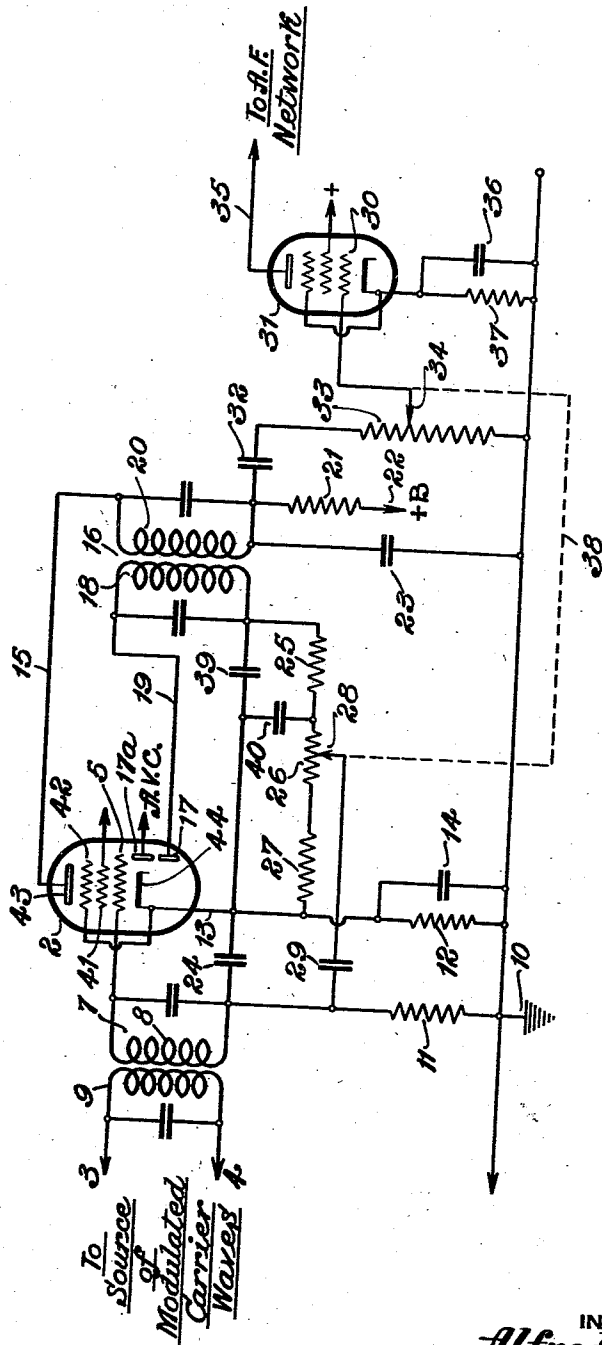
Sept. 29, 1942.

A. L. GREEN

2,296,921

REFLEX AUDIO AMPLIFIER CONTROL

Filed April 4, 1941



INVENTOR
Alfred L. Green
BY *H. S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,296,921

REFLEX AUDIO AMPLIFIER CONTROL

Alfred Leonard Green, Sydney, New South Wales, Australia, assignor to Amalgamated Wireless (Australasia) Limited, Sydney, New South Wales, Australia, a company of New South Wales, Australia

Application April 4, 1941, Serial No. 386,799
In Australia July 26, 1940

2 Claims. (Cl. 250—20)

This invention relates to volume control in radio receivers, and more particularly is directed to volume control arrangements for use in radio receivers of the reflex type which employ a circuit wherein the signal is amplified both before and after detection in the same amplifier valve or valves.

In order to control the output volume level from a receiver of the type specified, it has been customary to provide a manually operable volume control for varying the amplitude of the audio frequency potentials applied to the input of the reflexed amplifier valve. This method of volume control is unsatisfactory, as it is only possible to obtain zero output volume at zero audio input to the reflexed amplifier valve when the latter exhibits perfect linear characteristics. This desirable operating condition, however, is not readily obtainable in practice as there usually exists a certain amount of non-linearity in the mutual conductance characteristic of the reflexed amplifying valve which non-linearity introduces undesirable effects into the operation of the receiver. The most noticeable defects are inability to control the output volume to zero, and very marked increase in distortion as the receiver output volume level is reduced.

When operating over a non-linear mutual conductance characteristic, a carrier frequency input to the reflexed amplifying valve produces audio frequency as well as carrier frequency currents in the anode circuit. In a reflexed amplifier, the audio frequency currents thus produced must flow through the anode load resistor and build up voltages thereacross which are passed directly to the following amplifying valve. In this way the undesired audio frequency potentials, resulting from the non-linear characteristic of the reflexed amplifying valve, produce an audio output independent of the setting of the volume control associated with the audio frequency input to the reflexed valve. This becomes particularly noticeable when the volume control is turned completely "off," and is, therefore, termed the "minimum volume" output.

The minimum volume output is markedly distorted and is in anti-phase with the desired output voltage produced by applying the output of the carrier frequency rectifier to the input of the reflexed amplifying valve. Consequently, as the volume control setting is increased from zero, the audio output of fundamental frequency first decreases almost to zero and then rises as the

minimum volume output is overcome. When the two audio outputs of fundamental frequency are almost balanced out, the output from the loudspeaker consists mainly of the distortion voltages in the minimum volume output and the initial distortion percentage is, therefore, very high. It has been suggested that, in order to overcome these defects, volume control should be provided in the input circuit of the output valve. However, a volume control in the plate circuit of the reflexed amplifier valve (and thus in the grid circuit of the following valve), controlling the amount of audio voltage delivered to the grid of the following valve, has several disadvantages, one being that the reflexed amplifying valve operates at maximum audio output at all times with consequent maximum distortion.

The object of this invention, therefore, is to provide improved volume control in radio receivers of the reflex type whereby the aforesaid disadvantages are avoided.

According to the invention, a volume control for radio receivers of the reflex type comprises means for manually varying the amplitude of the audio frequency signal potentials applied to the input of the reflexed amplifier valve, means for preventing the reduction of said audio frequency potentials to zero by operation of said first mentioned means, and additional means for manually varying the audio frequency potentials applied to the input of an amplifier valve, or valves, following said reflexed amplifier valve.

The invention, however, will be better understood from the following description when read in connection with the drawing which illustrates one practical method of carrying the invention into effect.

Referring to the above drawing, signal-modulated carrier frequency energy is applied to the terminals 3, 4, coupled to the control grid 5 of the amplifier section of valve 2 through a carrier frequency input circuit 7. The latter circuit includes a suitable radio frequency input impedance or coupling device, such as the tuned secondary 8 of the coupling transformer 9. The grid 5 of the valve 2 receives a suitable biasing potential through this circuit, and through a low potential supply lead therefor connected to earth 10 through a coupling resistor 11. The biasing potential is supplied from any suitable source such as a self-bias resistor 12 in the cathode return lead 13. The self-biasing resistor 12 is shunted by a suitable radio frequency and audio frequency bypass condenser 14. A suit-

able carrier frequency bypass for the circuit 7 directly to the cathode lead 13 is provided by the condenser 24. The input circuit 7 is tuned to the carrier frequency of the incoming signal, such as, for example, the selected intermediate frequency (I. F.) in a superheterodyne receiver, or the carrier wave frequency in a tuned radio frequency type of receiver.

The high frequency, or I. F., signals delivered to the control grid 5, from the input circuit 7, are amplified in the amplifier section of valve 2, and the amplified carrier frequency signals appearing in the anode circuit 15 are passed through a coupling device 16 to the carrier frequency rectifier 17, 44. In the present example, the valve 2 is shown as a multiple valve of the well known 6E8G type containing, within a single envelope, an amplifier section comprising the cathode 44, the control grid 5, the screen grid 41, the suppressor grid 42 and the main anode 43, and a rectifier section comprising a pair of independent diode anodes 17 and 17a. The latter are disposed adjacent a portion of the cathode 44 which provides an electron stream to said anodes 17, 17a only.

Although the above mentioned amplifier and rectifier sections are shown as being housed within a single envelope 2, it is to be clearly understood that separate valves may be used if desired, and that any suitable form of rectifier other than a diode may be employed without effecting the scope of the invention.

The coupling device 16 may consist of an I. F. transformer in the amplifier output circuit 15, and having a secondary 18 connected to a lead 19 in the diode rectifier circuit. The low potential side of the primary 20 of transformer 16 is connected through the anode load resistor 21 to the positive terminal 22 of a suitable direct current potential supply source (not shown). A suitable by-pass condenser 23 is provided between the low potential end of primary 20 and earth. The low potential side of the secondary 18 is connected, through the diode load resistance comprising a filter resistance 25, the volume control potentiometer resistance 26 and the stopper resistance 27, to the common cathode lead 13. The moving contact 28 of the volume control potentiometer resistor 26 is connected through a coupling condenser 29 to the low potential end of the input secondary 8 between the latter and the coupling resistor 11. Carrier components are by-passed to the cathode in the rectifier output circuit by condensers 39, 40.

From the description of the drawing thus far, it will be seen that modulated high frequency, or I. F., energy, applied to the input terminals 3, 4, is amplified. The amplified energy appearing in the output circuit 15 is rectified in the rectifier 17-44. The audio frequency potentials developed across a portion of the rectifier output circuit 25, 26, 27 are applied in controllable amplitude to the input circuit 7 of the amplifier section of tube 2. The audio frequency potentials are simultaneously amplified with the carrier potentials in the amplifier section of tube 2 and appear in amplified form across the anode load resistor 21.

Amplified audio frequency potentials, developed across the anode load resistor 21, are applied to the control grid 30 of an audio frequency amplifying valve 31 through a resistance capacity coupling network comprising the coupling condenser 32 and the grid resistance 33. The grid resistor 33 may be constituted wholly or in part

by the resistance of an additional volume control potentiometer device, the moving arm 34 of which is connected to the control grid 30 of the valve 31 to control the amplitude of the audio frequency potentials applied thereto. The amplified audio frequency potentials appearing in the output 35 of the valve 31 may be applied either directly, or after still further amplification, to the audio utilization means (not shown). Although the valve 31 is shown as a pentode, it is to be understood that any suitable type of audio frequency amplifying valve may be employed. Further, the invention is not limited to the use of resistance coupling for transferring the amplified audio frequency potentials in the output of the valve 2 to the input of the valve 31. It is quite conceivable that transformer coupling may be desirable in some particular applications, and, also, that instead of a single valve 31 a plurality of valves may be employed in the well-known parallel, or push-pull, connections. These alternative coupling methods are well known to those skilled in the art, and consequently a detailed description thereof is considered unnecessary. The essential feature for the purpose of this invention, irrespective of the type of coupling employed, resides in the provision of an additional volume control for controlling the amplitude of the amplified audio frequency energy which is fed to the amplifier valve or valves at 31.

Suitable operating potentials are supplied to the anodes, screens and heaters of the valves 2 and 31 in any well known manner from a suitable supply source (not shown). The biasing potentials for the valve or valves at 31 may be obtained and applied to the grid in known manner, as, for example, as shown in the drawing by the usual capacity-by-passed cathode bias resistor 36, 37, or in any other convenient manner.

From an inspection of the circuit drawing it will be seen that instead of the single volume control 26 which is usually employed in receivers of the type under discussion, the invention provides an additional volume control 33, which may be operated independently of the volume control 26, or, if desired, may be ganged thereto for simultaneous operation therewith, as indicated by the dotted link 38. The volume control 33 makes it possible to reduce the receiver output volume to zero, which is not usually possible if the potentiometer 26 is the sole volume control, consequent upon the previously mentioned minimum volume output, developed across 21 independently of the setting of 26, as a result of non-linearity in the characteristic of the amplifier 6.

Inclusion of the stopper resistor 27 (inserted between the low potential end of the volume control resistor 26 and the cathode 44) insures that reduction to zero of the audio frequency input to valve 2 cannot be effected by moving arm 28 of volume control 26 into its minimum setting. It, therefore, follows that the desired output across the anode load resistor 21 can never be completely cancelled by the undesired minimum volume effect which is always present in 21.

As previously explained, if the two outputs of fundamental frequency are almost balanced out, the final output consists mainly of the distortion voltages in the minimum volume output, and the initial distortion percentage is, therefore, very high. As the audio input to tube 2 from the detector diode 17-44 is increased, the distortion voltages become an increasingly smaller percentage of the total output, and the distortion

percentage, therefore, decreases. The value of the stopper resistance 27 should be chosen so that, independent of the setting of the moving arm 28 of the volume control potentiometer 26, the desired audio frequency level across the output load resistor 21 of the reflex amplifier is always much greater than the undesired minimum volume output signal. This results in a considerable reduction in percentage of distortion present in the desired output.

The first volume control 26 and associated stopping resistor 27 provides means for regulating the amplitude of audio potentials applied to the input 7 of the reflex amplifier so as to prevent overloading by stray signals. At the same time it assures that, independent of the adjustment of the volume control 26, the level of the useful signal across the anode load 21 is always greater than the undesired minimum volume output. The second volume control 33 placed in the grid circuit of the output valve 31 provides means for reducing the receiver output level to zero.

As only one diode (17) in valve 2 is required for detection, the other diode (17a) may be fed with high frequency potentials from a suitable point in the carrier amplifier circuits and used to provide A. V. C. bias for the preceding carrier-frequency stages. On the other hand, the two diode anodes may be conductively coupled together, and the desired A. V. C. potentials obtained from a suitable point in the diode load circuit in known manner.

What is claimed is:

1. In a radio receiver of the type specified a volume control arrangement comprising a first volume control means for manually varying the amplitude of audio frequency signal potentials

applied to the input of a reflexed amplifier valve, means for preventing reduction to zero of said audio frequency potentials by operation of said first mentioned means, additional means electrically independent of said first volume control means for manually varying the audio frequency potentials applied to the input of an amplifier valve following said reflexed amplifier valve and said means for manually varying the amplitude of the audio frequency potentials impressed on the reflexed valve comprising a resistance forming part of the load resistance of a demodulating rectifier.

2. In a radio receiver, an amplifying valve having a non-linear characteristic adapted for the simultaneous amplification of radio and audio frequency signals, means connected in the output circuit of said amplifying valve for obtaining the amplified radio frequency energy, additional means in said output circuit for obtaining the amplified audio frequency energy, means for rectifying said amplified radio frequency energy, volume control means for applying the modulation energy in the output circuit of said rectifier in controllable amplitude to the input of said amplifying valve, a stopper resistor connected with said volume control for preventing the reduction to zero of said modulation energy by operation of said volume control, additional volume control means for applying the amplified modulation energy in the output circuit of said amplifying valve in controllable amplitude to the input of the following amplifier, and means for mechanically coupling said first mentioned volume control and said additional volume control for simultaneous operation.

ALFRED LEONARD GREEN.