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C. J. VAN LOON

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DELAYED AUTOMATIC VOLUME CONTROL CIRCUITS

Filed March 10, 1938

Fig. 1

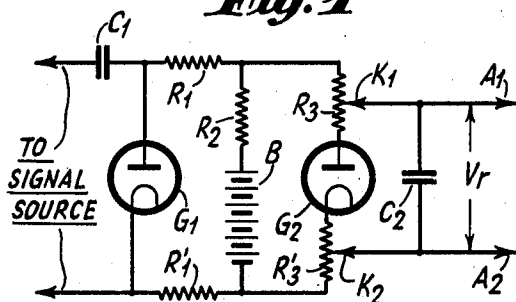


Fig. 2

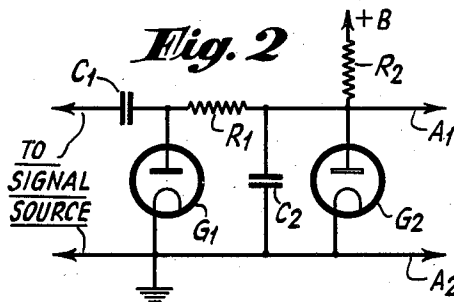


Fig. 3

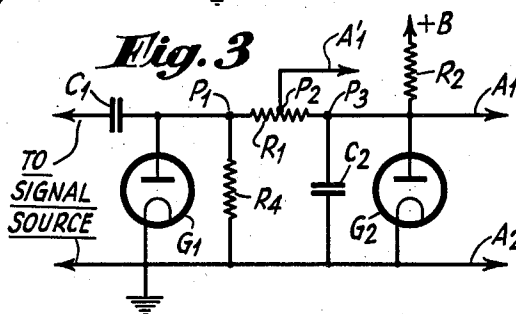


Fig. 4

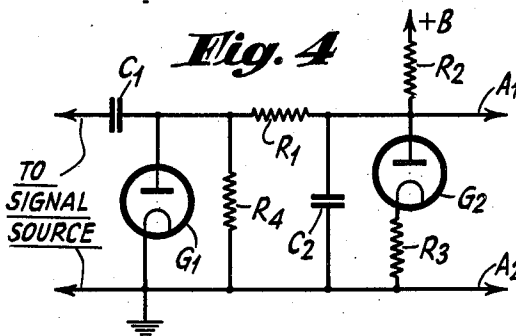


Fig. 5

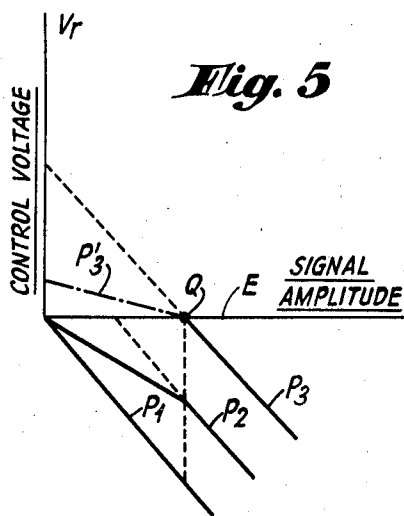
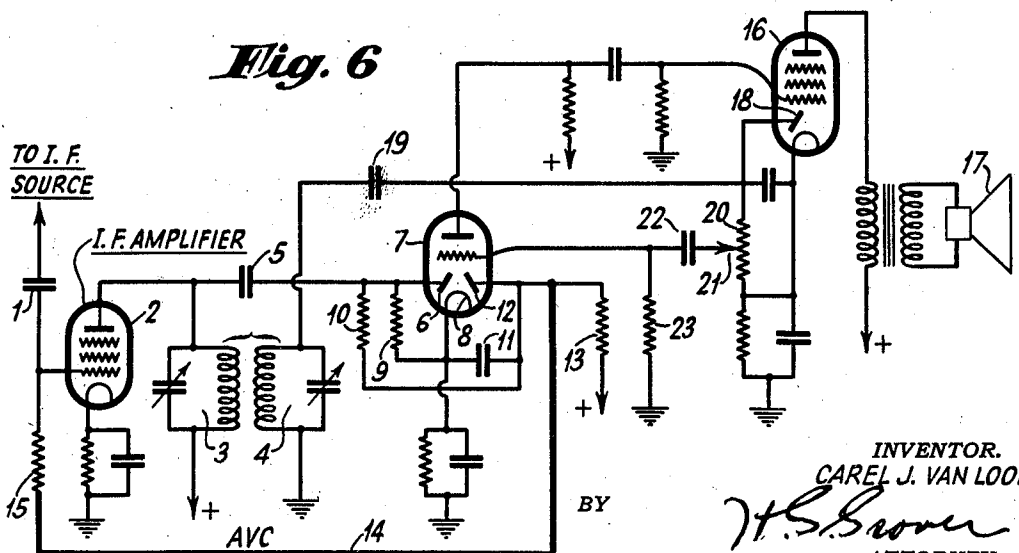


Fig. 6



INVENTOR.
CAREL J. VAN LOON
C. J. Van Loon
ATTORNEY.

UNITED STATES PATENT OFFICE

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DELAYED AUTOMATIC VOLUME CONTROL
CIRCUITS

Carel Jan van Loon, Eindhoven, Netherlands, assignor, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

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4 Claims. (Cl. 250—20)

The invention relates to a circuit arrangement for delayed automatic volume control which is particularly suitable for use in radio receivers. By a delayed automatic volume is meant such an automatic control of the amplification of one, or more, amplifying tubes of a radio receiving, or similar, system in dependence on the mean amplitude of the oscillations supplied, that the amplification of the controlled amplifying tubes is not, or only slightly, altered so long as the amplitude of the oscillations supplied is below a determined threshold value, whereas with amplitudes exceeding this threshold value the amplification of the controlled amplifying tubes is decreased with an increasing amplitude in such manner that the mean output voltage of the system remains approximately constant.

With the circuit arrangements for delayed automatic volume control which have been utilized up to the present, the control rectifier has been applied to it a negative bias voltage which is so chosen that a control voltage is only set up with amplitudes above the threshold value. These circuit arrangements have the considerable disadvantage that the rectified voltage set up across the control rectifier is greatly distorted due to the presence of the negative bias, since only that proportion of the incoming oscillations is rectified whose amplitude is larger than the bias voltage. This drawback is particularly troublesome when the control rectifier serves at the same time for the detection of the oscillations received. However, even if for the purpose of detection a separate rectifier is provided, a distorted reproduction will be obtained, since the distorted voltage set up across the control rectifier is transferred to the detector due to the mutual coupling of the two rectifiers. Besides, the control rectifier causes damping of the preceding oscillatory circuit (which damping depends on the amplitude) owing to which, also, distortion is brought about. There has previously been proposed a circuit arrangement wherein the negative bias of the control rectifier disappears when the threshold value is surpassed, the above-mentioned drawback being thus, however, not conclusively eliminated; since in the case of small signal amplitudes distortion still occurs.

According to the invention, a circuit arrangement for delayed automatic volume control which is substantially free from distortion is obtained by connecting in parallel with a control rectifier, to which the received oscillations are supplied, an impedance which comprises the series connection of at least a smoothing resistance and

a second rectifier; the second rectifier being included at the same time in a circuit which comprises at least a source of voltage in series with a second resistance. The arrangement is such that by the control rectifier a negative voltage depending on the amplitude of the oscillations received and by the source of voltage a positive voltage is applied to the anode of the second rectifier, which positive voltage renders the second rectifier conductive so long as the amplitude of the received oscillations is located below a determined threshold value, the bias of the amplifying tubes to be controlled being taken from part of the impedance connected in parallel with the control rectifier, which part includes the second rectifier.

The invention will be explained more fully with reference to the accompanying drawing wherein:

Fig. 1 illustrates the general principle of the invention;

Figs. 2, 3 and 4 represent other modifications,

Fig. 5 shows a graphic analysis,

Fig. 6 illustrates the application of the invention to a radio receiver.

The circuit arrangement shown in Fig. 1 comprises a control rectifier G_1 to which the received oscillations are applied through the intermediary of a coupling condenser C_1 . The control rectifier G_1 has connected in parallel with it an impedance which consists of the series connection of one, or more, smoothing resistances R_1 and R'_1 , a second rectifier G_2 and, if desired, one or more further resistances R_3 and R'_3 . The second rectifier G_2 is included at the same time in a circuit which comprises a source of voltage B in series with a resistance R_2 . The source of voltage B is shown as a battery, but it may also be formed by any other source of voltage, e. g., a resistance which is traversed by the anode current of one or more electron discharge tubes. The source of voltage B applies a positive voltage, and the rectifier G_2 a negative voltage which depends on the amplitude of the received oscillations, to the anode of the rectifier G_1 . The bias voltage of one, or more, amplifying tubes which are to be controlled is taken, by means of adjustable contacts K_1 and K_2 , from part of the impedance connected in parallel with the control rectifier G_1 , which part includes the second rectifier G_2 .

In the circuit arrangement shown in Fig. 1 the contacts K_1 and K_2 are connected to resistances R_3 and R'_3 , but alternatively the contact K_1 may be connected to a point of the smoothing resistance R_1 and the contact K_2 to a point of the smoothing resistance R'_1 . The control

voltage V_r is supplied by conductors A_1 and A_2 to the amplifying tubes to be controlled, a smoothing condenser C_2 being arranged between said conductors. It would, however, also be possible to provide this smoothing condenser at another point, for example, between the junction points of the resistances R_1 and R'_1 with the resistances R_3 and R'_3 .

The system operates as follows: With amplitudes of the received oscillations which are below a determined threshold value, the voltage supplied by the source of voltage B to the anode of the rectifier G_2 is larger than the negative voltage supplied by the control rectifier G_1 so that the rectifier G_2 is conductive and forms a short-circuit for the bias voltage to be supplied to the tubes which are to be controlled; no bias at all, or only a slight bias, being consequently supplied to the tubes to be controlled. In the case of amplitudes exceeding the above-mentioned threshold value, the negative voltage supplied by the rectifier G_1 to the anode of the rectifier G_2 is larger than the positive voltage supplied by the source of voltage B so that the rectifier G_2 is blocked and the tubes to be controlled have supplied to them a control voltage dependent on amplitude which is sufficiently large to keep the mean output voltage approximately constant. The rectifier G_2 has supplied to it either no bias at all or a positive bias so that the distortion of the rectified voltage set up across the rectifier G_1 is eliminated almost completely. There will still be, in general, a slight distortion since the direct current resistance of the output circuit of the rectifier G_1 is not equal to the alternating current resistance. This distortion is, however, not very troublesome, and besides it can be decreased by arranging a leakage resistance in parallel with the rectifier G_1 .

In the system, according to the invention, the rectified voltage set up across the rectifier G_1 is in general so slightly distorted that without any objection the rectifier G_1 may also be utilized for the detection of the received oscillations. For receivers of high quality it is, however, advisable to provide for detection a separate rectifier which is provided in this case, in order to avoid capacitative coupling with the previously mentioned rectifiers, in a tube other than these rectifiers. A very suitable arrangement consists, for example, in that in a receiver having two low frequency amplifying tubes, the two first-mentioned rectifiers are formed by diodes which are provided in the first low frequency amplifying tube, whereas the detector consists of a diode provided in the second low frequency amplifying tube. Although in the system shown in Fig. 1 the rectifiers G_1 and G_2 are shown as diodes, it is obvious that the system may also be equipped with other rectifiers, for example with dry rectifiers.

Figs. 2, 3 and 4 represent a few practical embodiments of the invention. In the system shown in Fig. 2 the received oscillations are supplied through a coupling condenser C_1 to control rectifier G_1 . The output circuit of the rectifier G_1 comprises a smoothing resistance R_1 and a second rectifier G_2 which has connected in parallel with it a smoothing condenser C_2 . A positive direct current voltage is supplied, through a resistance R_2 , to the rectifier G_2 .

The system according to Fig. 3 substantially differs from the system shown in Fig. 2 in that a leakage resistance R_4 is connected in parallel with the rectifier G_1 , owing to which the direct current resistance of the output circuit of the

rectifier G_1 can better be made equal to the alternating current resistance with the result that a further reduction of the distortion of the voltage set up across the rectifier G_1 is obtained. This circuit arrangement may, therefore, be utilized quite satisfactorily if the rectifier G_1 serves at the same time as a detector, in which event the low frequency oscillations may be taken from part of the leakage resistance R_4 . In Fig. 3 there is provided, furthermore, a conductor A'_1 through the intermediary of which a control voltage is supplied to one or more amplifying tubes which differs from that supplied to the other tubes, the variation of this control voltage being shown in Fig. 5 as a function of the amplitude of the received oscillations. The conductor A'_1 is connected to a point P_2 of the smoothing resistance R_1 which is located between the ends P_1 and P_3 .

Fig. 5 shows the variation of the direct current voltage produced in the system according to Fig. 3 at the points P_1 , P_2 and P_3 as a function of the amplitude E of the received oscillations. At the point P_1 there occurs a negative voltage which is proportional to the amplitude of the received oscillations. If the rectifier G_2 were not present, the voltage at the point P_3 would have a shape as indicated by the dotted portion of the line P_3 . With the amplitudes below the threshold value Q the rectifier G_2 forms, however, a short-circuit so that below the threshold value substantially no voltage occurs between the conductors A_1 and A_2 . The voltage set up at the point P_2 is indicated in Fig. 5 by a broken line P_2 . With amplitudes lower than the threshold value there exists at the point P_2 a small negative voltage which depends on the amplitude, whereas with amplitudes above the threshold value a large negative voltage dependent on the amplitude is set up. In many cases it is desirable, for the purpose of reducing the tube noises to a minimum, to control the first tube of a radio receiving system with an appreciable delay and the following tubes with a slight delay. The first tube may be connected in this case to the conductor A_1 and one or more of the other tubes to the conductor A'_1 .

In the system shown in Fig. 4 a resistance R_3 is connected between conductor A_2 and the cathode of rectifier G_2 . With amplitudes below the threshold value there consequently occurs between conductors A_1 and A_2 a positive voltage which decreases with the amplitude as is indicated in Fig. 5 by a dot-and-dash-line P'_3 . This positive voltage may serve, for example, to decrease, in the case of very small amplitudes, the amplification of the controlled tubes by means of the damping brought about by grid currents, owing to which during tuning disagreeable parasitic noises are suppressed. This positive voltage may, also, be utilized for the opposite purpose, that is to say for neutralizing fading phenomena even at small amplitudes if a negative bias is oppositely connected to the positive voltage, for example by providing a resistance in the cathode lead of the controlled tubes. In this case the amplification of these amplifying tubes is controlled in a similar manner as in the case of connection to conductor A'_1 in the system according to Fig. 3.

Fig. 6 represents part of a radio receiving system to which the invention is applied. The intermediate frequency oscillations set up by a mixing tube, which is not shown, are supplied by a coupling condenser 1 to the control grid of an intermediate frequency amplifying tube 2 whose anode circuit comprises the first circuit 3 of a

band-pass filter which consists of two mutually coupled circuits 3 and 4 which are both tuned to the intermediate frequency. The oscillations set up across the circuit 3 are supplied, through the intermediary of a coupling condenser 5, to the diode anode 6 of a duo-diode-triode 7, which anode 6 forms, jointly with a cathode 8, the control rectifier G_1 shown in Figs. 1-4. Across a leakage resistance 9 there is set up a control voltage which is supplied, through the intermediary of a filter consisting of a smoothing resistance 10 and a smoothing condenser 11, to an anode 12. The latter forms, jointly with the cathode 8, the second rectifier G_2 shown in Figs. 1-4. A positive bias is applied to the anode 12 through the resistance 13. The control voltage is supplied by a conductor 14 to the tubes to be controlled; the voltage is supplied through a resistance 15 to the tube 2.

The anode circuit of the amplifying section provided in tube 7 is connected by a resistance-condenser coupling to the control grid circuit of a second low frequency amplifying tube 16, the output circuit of which includes a reproducing device 17. The tube 16 contains a diode anode 18 which forms, jointly with the cathode of tube 16, a rectifier which serves for the detection of the received oscillations. To that end the oscillations set up across the circuit 4 are supplied by a condenser 19 to the anode 18. The low frequency oscillations set up across the resistance 20 are supplied by means of a slide contact 21 which acts as volume controller, through a condenser 22, to the control grid of the amplifying section provided in tube 7, said control grid being grounded by a leakage resistance 23. Owing to the fact that the detector is provided in tube 16, whereas the two other rectifiers are provided in tube 7, the capacitive coupling of the detector with the other rectifiers is reduced to a minimum. A suitable value for the leakage resistance 9 is, for example, 0.5 megohm, whereas the resistance 10 amounts, for example, to 1 megohm, and the condenser 11 has a capacity of 0.1 mf.

What is claimed is:

1. In a radio receiver, a tube provided with a cathode, control grid, plate and at least two auxiliary anodes, a tuned signal input circuit connected between the cathode and one anode to provide a diode signal rectifier, means connecting the diode provided by the cathode and second anode across the first diode, means for biasing the second anode positive with respect to said cathode, means for deriving a direct current voltage from signal current rectified by said rectifier, means for applying said voltage to said second anode in opposition to said positive biasing means whereby said voltage is adapted for control use, a second tube having at least an amplifier section and a diode, means for applying signals to said last diode for detection, means applying the detected signals to said grid, and

means for transmitting from said plate to said amplifier section amplified detected signals.

2. In combination with a signal amplifier, a diode rectifier network having an input circuit coupled to said amplifier, said network including a direct current voltage connection to said amplifier for gain control of the latter, a second diode having its space current path in shunt with the first diode, means rendering said second diode normally conductive for signals below a desired amplitude thereby to prevent rectified signal voltage from being transmitted over said connection, said network including a load resistor connected between the first diode anode and cathode, said second diode anode being connected to the anode end of said load resistor through a filter resistor whereby said second diode is rendered non-conductive upon the signal strength exceeding said desired amplitude, a signal detection network, a signal transmission network coupled to said rectifier input circuit, and connections from said detection network to said transmission network.

3. In combination with a signal amplifier, a diode rectifier network having an input circuit coupled to said amplifier, said network including a direct current voltage connection to said amplifier for gain control of the latter, a second diode having its space current path in shunt with the first diode, means rendering said second diode normally conductive for signals below a desired amplitude thereby to prevent rectified signal voltage from being transmitted over said connection, said network including a load resistor connected between the first diode anode and cathode, said second diode anode being connected to the anode end of said load resistor through a filter resistor whereby said second diode is rendered non-conductive upon the signal strength exceeding said desired amplitude, said amplifier having said diode input circuit in its output, a tuned signal circuit coupled to said input circuit, and a detection network coupled to the tuned signal circuit.

4. In combination with cascaded signal circuits, a diode signal rectifier coupled to the first signal circuit and including a load impedance for developing a unidirectional voltage from rectified signal current, a gain control connection to said impedance for utilizing said voltage, diode means normally rendering the control connection ineffective to utilize said voltage for signals below a desired amplitude, a tube provided with a diode section and an amplifier section, a signal coupling path between said diode section and the second of said cascaded circuits whereby signals are detected, a second tube including the electrodes of said first diode and the electrodes of an amplifier, means for impressing the detected signals upon the last named amplifier, and additional means for transmitting the amplified detected signals to said amplifier section.

CAREL JAN VAN LOON.