May 7, 1940. Y. B. F. J. GROENEVELD 2,200,062

AUTOMATIC VOLUME CONTROL

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Fig. 1

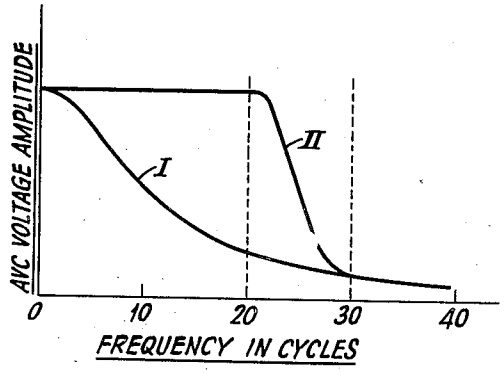


Fig. 2

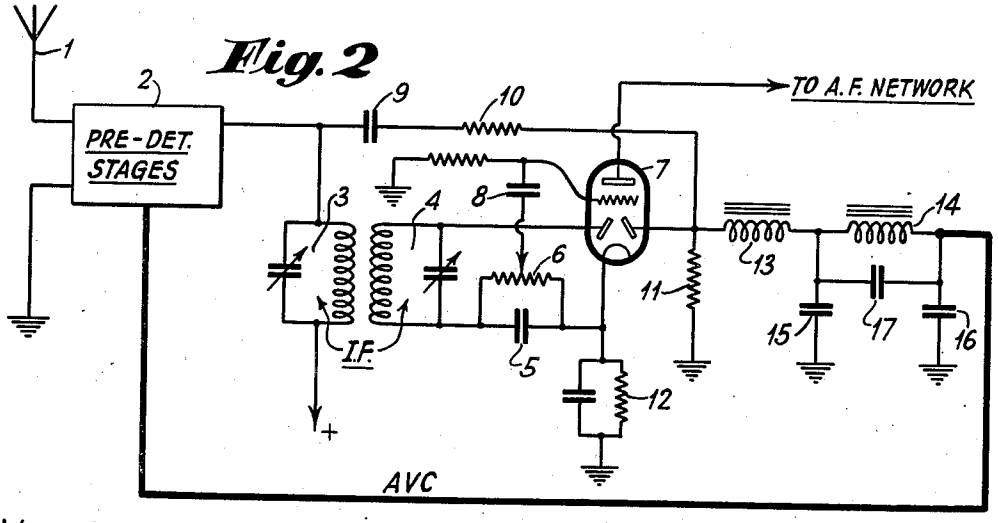
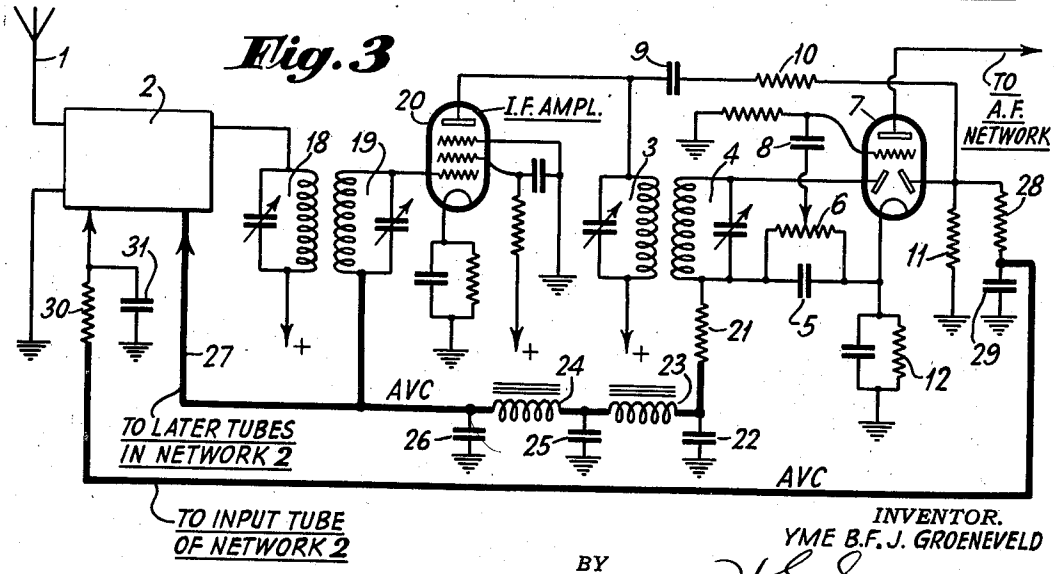


Fig. 3



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AUTOMATIC VOLUME CONTROL

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4 Claims. (Cl. 250—20)

This invention has reference to a wireless receiver with fading compensation for the reception of short waves.

In the well-known receivers with fading compensation the received signal is rectified by a control rectifier in whose output circuit both a direct current voltage governed by the carrier wave amplitude of the signal and a low-frequency voltage governed by the modulation of the signal occur. For the purpose of compensating for fading phenomena the direct current voltage component of the output voltage of the control rectifier is supplied in such a manner to one, or more, control electrodes of the tubes contained in the receiver that the gain of these tubes decreases with increasing carrier wave amplitude of the received signal. In this case, the low-frequency component of the output voltage of the control rectifier must be kept away from the controlled tubes, since, otherwise, a compensation for the carrier-wave variations governed by the modulation of the signal, that is suppression of the modulation, would occur. It is, therefore, common practice to supply the control voltage to the controlled tubes by a filter which consists of resistances and condensers, and whose time-constant is high relative to the period of the lowest modulation frequency to be reproduced. The inertia of the control caused by the high time-constant of the filter is quite permissible when long or medium waves are received, since in this case very slow variations of the carrier wave amplitude alone are encountered.

In the reception of short waves, however, sufficient compensation for fading phenomena is not secured with the usual receivers, since in the case of short waves (for example lower than 100 meters), particularly in the reception of remote transmitters, very rapid variations of the carrier wave amplitude may occur which cannot be followed by the usual inert regulator. The fading phenomena that occur in the reception of short waves frequently elapse even within a time interval of about $\frac{1}{20}$ second so that for the purpose of compensation a control voltage would be necessary which contains an alternating voltage component having a frequency of 20 cycles. Obviously, this alternating voltage component is not passed by the R C filter with high time-constant which, with the usual receivers, is included between the control rectifier and the tubes to be controlled. A decrease of the time-constant of this filter is, however, not admissible since suppression of the lowest modulation frequencies would thereby be brought about.

The invention has for its object to provide a fading controller which even in the case of short wave reception ensures satisfactory compensation for the fading phenomena.

According to the invention, this object is achieved by deriving the fading control voltage for one or more tubes from the control rectifier by a low-pass filter which at a frequency slightly below the lowest modulation frequency to be reproduced by the receiver cuts off sharply. Preferably, the filter is such that a frequency of 20 cycles/sec. is passed unweakened, and a frequency of 30 cycles/sec. is suppressed almost completely.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully, by way of example, with reference to the accompanying drawing wherein Fig. 1 graphically illustrates the characteristic of the present invention, Fig. 2 shows one embodiment of the invention, and Fig. 3 illustrates still another embodiment of the invention.

The curves shown in Fig. 1 illustrate the operation of the fading controller hitherto used, and that according to the invention. The curve I represents the frequency characteristic curve of a usual R C filter with a high time constant. As may be seen from the drawing even a frequency of about 20 cycles/sec. is substantially no longer passed by this filter. The curve II shows the frequency characteristic curve of the filter used in accordance with the invention, said filter allowing a frequency of 20 cycles/sec. to pass unweakened and suppressing almost completely a frequency of 30 cycles/sec.

Fig. 2 shows the parts of a wireless receiver which are necessary for an understanding of the invention. The signal oscillations in the aerial 1 are supplied to the pre-detector network 2 of a superheterodyne receiver. This network contains the local oscillator, the mixing stages and in some cases one, or more, high and/or intermediate frequency amplifier stages. The output voltage of the network 2 is supplied to an oscillatory circuit 3 tuned to the intermediate frequency, and coupled to a second intermediate frequency circuit 4. The circuit 4 is connected, in series with an output resistance 6 shunted by a condenser 5, to a diode contained in the valve 7. The low-frequency oscillations that occur across the resistance 6 are supplied by a coupling condenser 8 to the control grid of the amplifier section contained in the valve 7. The intermediate frequency voltage occurring across the circuit 3 is supplied by a coupling condenser 9 and an attenuation resistance 10 to a second diode contained in the

valve 7, and serving as a control rectifier for fading compensation.

A control voltage, depending on the carrier wave amplitude of the received oscillations, occurs across the resistance 11. The cathode circuit of the valve 7 includes a resistance 12 which serves for the production of the necessary grid bias for the amplifier section of the valve 7, but supplies at the same time a bias to the control rectifier so that a so-called delayed automatic volume control, that is to say a fading control which does not work until after the amplitude of the received oscillations has exceeded a given threshold value, is obtained in well known manner. According to the invention, the control voltage which occurs across the resistance 11 is supplied to the tubes, contained in the network 2, that are to be controlled by a filter which is constituted by inductance coils 13 and 14 and condensers 15, 16 and 17, and which cuts off sharply at a limit frequency slightly below the lowest modulation frequency to be reproduced. The parallel resonance circuit 14, 17 is tuned to the limit frequency for the purpose of increasing the selectivity of the filter.

In short wave receivers with fading compensation there is often the disadvantage that in spite of constant strength of sound the fading phenomena are brought out as a quick increase and decrease of the noise level. This phenomenon is due in particular to the quickly varying amplification factor of the input valve, since in the subsequent valves the signal amplitude is already large relative to the noise of the valve. It is thus possible materially to decrease the said disadvantage by causing the fading control not to work on the input valve, but only on the subsequent valves. When, however, the amplification of the input valve is constant under all conditions the risk occurs that the subsequent valves may be over-loaded on the reception of adjacent transmitters.

According to a further feature of the invention this disadvantage is obviated by deriving the fading control voltage for the input valve, or valves, of the receiver from the control rectifier by a filter with a high time constant, whereas the control voltage for the subsequent valves is derived from the regulating rectifier by a low pass filter which cuts off sharply at a frequency slightly below the lowest modulation frequency. Owing to these measures rapid variations of the amplification factor only occur with those valves in which the signal amplitude is already large relative to the valve noise, and over-loading of these valves on the reception of adjacent transmitters is avoided by adequate reduction of the amplification factor of the input valve, or valves, the inert control of the input valve, or valves, being admissible since in the case of adjacent transmitters which are received with high field intensity, rapid variations of the carrier wave amplitude generally do not occur. Preferably, in this circuit arrangement the amplification of the input valve, or valves, is controlled "in a delayed manner," that is to say reduction of the amplification of the input valve, or valves, does not occur until after the amplitude of the received oscillations has exceeded a given threshold value.

A receiver in which this feature of the invention is embodied is shown in Fig. 3. This figure shows an intermediate-frequency amplifier valve 20 which, by a band-pass filter constituted by the circuits 18 and 19, is coupled to the network 2 of the receiver. The fading control voltage for the valve 20 is obtained from the output resistance 6 of the detector by a filter of three sections; the first section is formed by a resistance 21 and a condenser 22, while the other sections are formed by inductance coils 23 and 24 and condensers 25 and 26. This filter cuts off very sharply at a frequency slightly below the lowest modulation frequency to be represented. The same control voltage which is supplied to the valve 20 is also supplied by a conductor 27 to the last valves contained in the network 2.

The input valve, or in some cases the two input valves of the receiver, have supplied to them by a filter with a high time constant, constituted by resistances 28 and 30 and condensers 29 and 31, the control voltage which occurs across the resistance 11; the direct voltage drop across the resistance 12 resulting in a "delayed" control of the input valve, or valves. In the circuit arrangement shown in Fig. 3 the detector is also used as a control rectifier. If in such a circuit arrangement a filter section constituted by inductance and condensers were connected to the output resistance 6, the highly variable total output impedance of the detector as a function of frequency would bring about distortion of reproduction. In order to avoid this, the first section of the filter circuit in the circuit arrangement shown in Fig. 3 is constructed as an R-C section (21, 22), the resistance 21 being large relative to the output resistance 6, care being taken that the R-C element 21, 22 passes any frequency below about 20 cycles/sec. substantially unweakened, since, otherwise, excessive inertia of the control would be brought about. The time constant of the R-C element should, therefore, be small relative to $\frac{1}{20}$ sec., so that the condenser 22 should have but a comparatively low capacity. Even in the use of a separate control rectifier it is preferable that the first element of the filter circuit should be formed as an R-C element, since there is almost always between the detector and the control rectifier a certain capacitative coupling which permits of a distorted low frequency voltage occurring in the output circuit of the control rectifier and being transmitted to the detector.

What is claimed is:

1. In a radio receiver of the short wave type, a modulated carrier amplifier having an input circuit upon which carrier energy of rapidly varying amplitude is impressed, said amplifier having a plurality of cascaded tubes, a carrier rectifier deriving a gain control voltage from amplified carrier energy, means applying the control voltage to a later one of the tubes of said amplifier in a gain reducing sense, and said applying means including a filter which passes voltage components up to 20 cycles, but suppresses substantially completely components above 30 cycles and additional means, including a higher time constant network, for decreasing the gain of an earlier one of said tubes, in response to said amplified carrier energy.

2. In a radio receiving system of the type comprising a plurality of cascaded modulated signal carrier transmission tubes, means deriving a unidirectional voltage from the transmitted carrier energy, means, including a network of a high time constant, for applying the voltage to at least one of the earlier tubes of the cascaded tubes in a gain reducing sense, means deriving a second unidirectional voltage from the transmitted carrier energy, means, including a network of a

relatively low time constant, for applying the second voltage to at least one tube following said one earlier tube, and said low time constant network consisting of a low pass filter which cuts off sharply at a frequency slightly below the lowest modulation frequency.

3. In a radio receiving system of the type comprising a plurality of cascaded modulated signal carrier transmission tubes, means deriving a unidirectional voltage from the transmitted carrier energy, means, including a network of a high time constant, for applying the voltage to at least one of the earlier tubes of the cascaded tubes in a gain reducing sense, means deriving a second unidirectional voltage from the transmitted carrier energy, means, including a network of a relatively low time constant, for applying the second voltage to at least one tube following said one earlier tube, said second deriving means additionally deriving a modulation voltage from the carrier energy, and a modulation voltage utilization network coupled thereto.

4. In a superheterodyne receiver of the short wave type including a signal conversion network and an intermediate frequency amplifier, a rectifier coupled to the amplifier for producing audio and direct current voltages, means for utilizing the audio voltage, an automatic volume control circuit connected between the rectifier and said amplifier, said control circuit including a low pass filter which cuts off sharply at a frequency slightly below the lowest audio frequency to be reproduced, a second rectifier coupled to said amplifier for producing a second direct current voltage, a second automatic volume control circuit connected between the second rectifier and a point of the receiver preceding said amplifier, said second control circuit including a high time constant network.

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