March 9, 1937. K. WILHELM 2,072,973

QUIET AUTOMATIC VOLUME CONTROL SYSTEM

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Fig. 1B

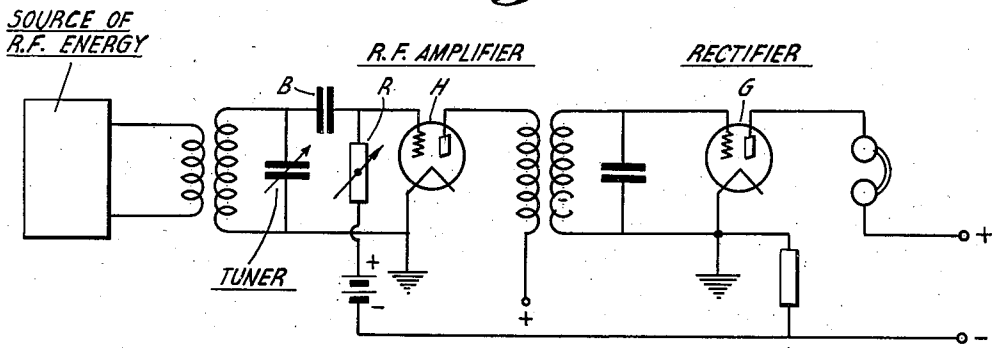


Fig. 1A

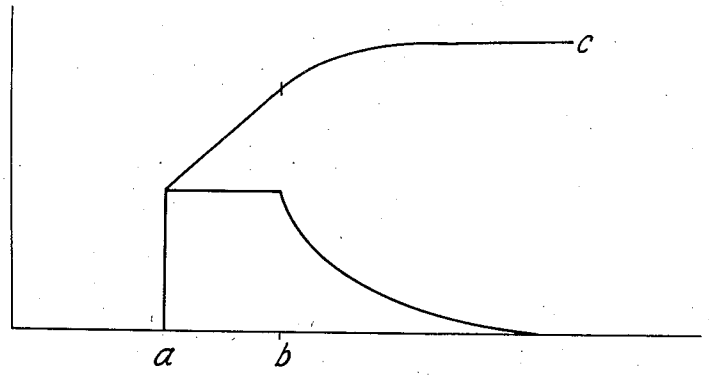
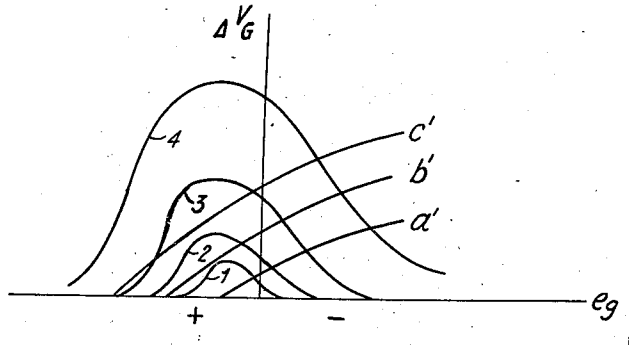


Fig. 2



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QUIET AUTOMATIC VOLUME CONTROL SYSTEM

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3 Claims. (Cl. 250—20)

The present invention relates to amplifiers with automatic sensitivity regulator means, especially radio receiver sets.

In the case of radio sets wherein the gain is automatically regulated, especially in radio reception, it is occasionally desirable to cause the apparatus to respond only whenever a certain threshold value arises. For instance, in radio reception it is mostly desired to receive only such stations as are above the general interference level so that, upon a change of tuning, it will be only these stations to which the receiver will respond, whereas in the intermediate tuning stages the set will remain unresponsive so that the interference level will remain inaudible.

The invention discloses ways and means to keep the gain of the receiver low whenever very low input potentials are dealt with, to cause an increase in the gain as the input potential rises; and, to cause a decrease thereof again as a maximum has been reached. In connection with the use of a "linear" rectifier, the result, for instance, will be that in the initial parts of the range there will be present an output voltage growing more than linearly with the input voltage, while after maximum gain has been reached, there is present an output potential growing less markedly than in direct proportion. This condition shall be explained in more detail by reference to the accompanying drawing, wherein Figs. 1A and 2 are graphical analyses of the operation of the invention, and Fig. 1B is a circuit employing the invention.

If the radio input voltage (see Fig. 1A) lies above a certain threshold value *a*, then the audio output rises in accordance with the portion indicated by *a*—*b* of the graph. But the regulating voltage at the rectifier is not yet adequate to occasion any substantial shift in the grid potential in the radio amplifier tubes.

Indeed, it is only when the normal voltage at the rectifier has been attained (point *b*) that the regulating action will be initiated. The audio output will then follow the portion of the graph indicated at *b*—*c*. It will be noted that the share of the interference which falls below radio amplitude *b* produces a certain volume in the loudspeaker. The part of the interference falling below *a* fails to produce any influence. Hence, this part of the interference is suppressed if a certain threshold value for the amplification is adopted.

All of the amplitudes which are less than *a* do not arise at all in the loudspeaker, while the amplitudes above *a* become audible in the presence of normal gain. The threshold value for the gain is created in the following manner (reference being made to Fig. 1B):

Upon the grid of the radio frequency amplifier tube H, to be regulated, there is impressed a suitable biasing voltage which must be positive. The application of this voltage to the grid is effected by way of a high-ohm resistance R (for instance, a resistance of 4 megohms). The risistor R is made adjustable for controlling the initial positive potential difference between the controlled amplifier grid and cathode. The grid oscillation circuit is protected against the flow of direct current by means of a blocking condenser B. Now, what happens is fundamentally the following: Suppose that at the grid of the first tube H, there arises a certain radio frequency potential. If the same has a certain value, there happens a shift in the grid potential after rectification by way of the tube G. The result is that the grid voltage of H is reduced. If the gain is thus raised in the set the amplitude at the rectifier will further increase until a state of balance is established.

For better understanding reference is made to a diagram as shown in Fig. 2, in which are plotted in inter-dependence the plate voltage shift at the rectifier and the resultant grid bias voltages of the regulated tube (the latter being indicated by the abscissae). For different steady biasing voltages there were found the graphs *a'*, *b'*, *c'*. Furthermore, the gain may be plotted as a function of the grid biasing potential. If this is done with radio frequency voltages of different amplitude there is obtained a family of curves shown in the diagram which are to have growing indices 1, 2, 3 . . . with increasing potentials.

Assuming, for instance, a linear rectifier, these curves as will be seen, give the output voltage at the rectifier, and thus indicate the attainable grid shift in the radio tubes. The points of intersection of the curves *a'*, *b'*, *c'*, with the curves 1, 2, 3, thus indicate the working points of the arrangement. Considering the scheme from a viewpoint of stability, in order to insure a stable working point there must be—

$$\frac{d\,(a, b, c)}{d\ e_g}$$

greater than

$$\frac{d\,(1, 2, 3 \ldots)}{d\ e_g}$$

It will then be noted that the points of intersection with the curve *a'* are all stable. (Here

no threshold value is obtainable.) But curve c' is suited for the present purposes. Points of intersection 1, 2, 3, result in unduly small gains. But curve 4 at its point of intersection on the right-hand side results in stable shifting which insures also adequate volume. Hence, regulating curves can be obtained of the kind shown in Fig. 1A.

Summarizing, the following may be said: The means used to attain the above end is to insure control action of the amplifier tubes into the positive range. As a consequence, a decrease in the gain, in the presence of a low input voltage, is attained by the damping of the circuits as grid current starts to flow. However, in order to render the damping smooth, in other words, in order that the curves 1, 2, 3, may not droop too steeply, the grid voltage is applied by way of a high resistance, the size of the latter being governed by the particular purpose or end aimed at in any given case. In order to obtain the various regulating graphs, the value of the positive biasing voltage of the radio tubes is regulable. The introduction of the resistances prevents the receiver from responding only to unduly high threshold values in case of faulty setting of the same, so that the receiver is rendered practically insensitive. It is for this reason that this adjustment has been made "soft" or smooth.

What is claimed is:

1. In a signal receiving system of the type including a signal frequency amplifier tube, a signal rectifier tube having an impedance in its space current path and an automatic amplifier gain control connection between the amplifier tube grid and a point on said impedance which is negative with respect to the amplifier cathode, said connection including a source of fixed positive voltage for initially maintaining the amplifier grid positive with respect to the amplifier cathode, the magnitude of said positive potential difference being such that grid current is caused to flow in the amplifier input circuit, when signals below a predetermined amplitude are received, thereby damping the amplifier input circuit sufficiently to prevent response to the last named signals, and the voltage developed across said impedance counteracting the effect of the fixed positive voltage in such a manner that the sensitivity of the amplifier is increased for signals for a small signal amplitude range above the said amplitude and decreased for all signal amplitudes above said range.

2. In a system as defined in claim 1, a resistor of a predetermined value connected between the fixed voltage source and the grid to regulate said damping action.

3. In a system as defined in claim 1, an adjustable resistor connected between the fixed voltage source and the amplifier grid for controlling the initial positive potential difference between the amplifier grid and cathode.

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