

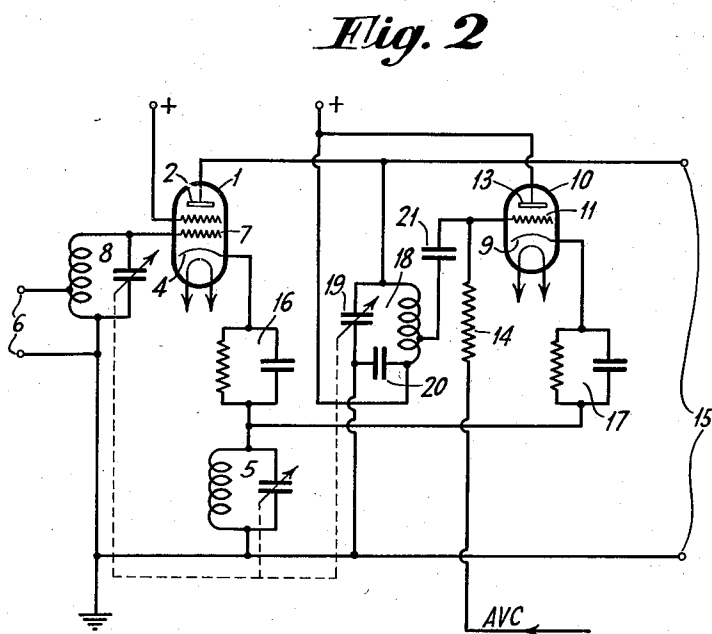
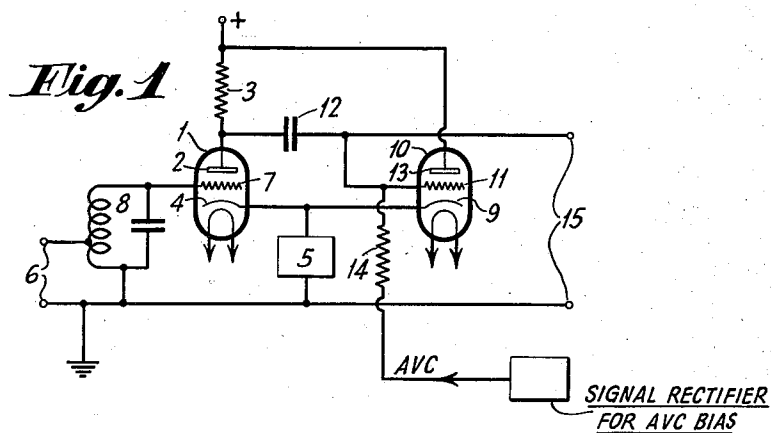
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AUTOMATIC GAIN CONTROL CIRCUITS

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AUTOMATIC GAIN CONTROL CIRCUITS

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This invention relates to gain control circuit arrangements and more particularly, though not exclusively, to arrangements for obtaining anti-fading automatic control of the gain of a carrier frequency stage or stages in a radio receiver.

It is common practice at the present time in radio receivers to obtain anti-fading automatic carrier frequency gain control by deriving a uni-directional potential dependent in magnitude upon received signal strength and utilizing this potential as grid basis for a so-called "variable-mu" carrier frequency valve in the receiver. In such gain control arrangements reliance for gain control is placed upon the curvature of the grid voltage-anode current characteristic of the "variable-mu" valve which is controlled, the slope of the characteristic being altered by varying the static bias on the valve.

A defect of a known arrangement as just described is that the whole of the signal input voltage is applied between control grid and cathode of the first valve of the receiver. Therefore, with a very strong input signal the curvature of the valve characteristic is by no means negligible with respect to the signal voltage and serious modulation distortion and cross-modulation interference often occurs. This distortion is particularly objectionable because, of course, it is the strong signals which are least affected by other forms of distortion, and are, in the case of a broadcast radio receiver, of most program value.

The main object of the present invention is to avoid this defect and to provide a method of automatic gain control which is such that the voltage applied between control grid and cathode of the first valve may always be maintained small with respect to the valve characteristic curvature, despite the automatic gain control action. By employing the present invention the stages of a radio receiver succeeding the present valve may be designed to give low distortion without having to be designed to accommodate large changes in input amplitudes.

According to this invention gain control is effected by utilizing uni-directional gain controlling potentials to vary the amplification of an auxiliary thermionic valve which receives input potentials derived from the output circuit of a valve whose gain is to be controlled, there being an impedance common to the cathode circuits both of the auxiliary valve and of the valve whose gain is to be controlled, and the whole arrangement being such that the net reaction or feed-

back effect upon the valve whose gain is to be controlled is varied in dependence upon the control exercised upon the amplification of the auxiliary valve. In other words, in accordance with this invention gain control is obtained by controlling in accordance with gain controlling potentials the resultant feedback effect of a feedback impedance associated with the valve whose gain is to be controlled this control being exercised by means of an auxiliary valve which is subjected to a varying bias potential dependent upon received signal strength.

In the case of automatic gain control—the usual case—the gain controlling potentials will be potentials obtained in any manner known per se, in dependence upon received signal strength.

The main advantages of this invention are:

- (1) The distortion is reduced to a minimum;
- (2) A large range of gain control is obtained; and
- (3) The gain control can be obtained by means of quite small controlling potentials.

The invention is illustrated in the accompanying drawing which shows diagrammatically two embodiments thereof in Figs. 1 and 2.

Referring to Fig. 1 which shows one embodiment of the invention a signal amplifier valve 1, for example a valve of the type commercially known in the United Kingdom under the trade designation Marconi MH4, has its anode 2 connected to a source (not shown) of anode potential through an anode resistance 3 of relatively low value (for the type of valve stated, about 120 ohms) the cathode 4 of the valve 1 being connected to earth through a feed-back impedance 5. The negative terminal of the source of anode potential is earthed, as in the usual way. Carrier frequency input potentials are applied from terminals 6 between the control grid 7 of valve 1 and earth by way of a tuned circuit 8 the input terminals 6 being preferably "tapped down" upon the coil of the tuned circuit 8 as shown. The cathode 4 of the valve 1 is also connected to the cathode 9 of an auxiliary valve 10 whose control grid 11 is connected to the anode 2 of the valve 1 through a condenser 12. The anode 13 of the auxiliary valve 10 is connected to the positive terminal of the source of anode potential and automatic gain controlling uni-directional potentials, derived in any convenient manner known per se from apparatus not shown, are applied to the control grid 11 of the auxiliary valve 10 through a grid resistance 14. Amplified output is taken off at terminals 15 from be-

tween the grid 11 of the auxiliary valve 10 and earth. The feed-back impedance 5 may conveniently be constituted by a tuned circuit.

With this circuit there will be negative feed-back voltage set up across the feed-back impedance 5 due to the valve 1 and positive feed-back voltage will be set up across the said impedance 5 due to the auxiliary valve 10. The arrangement is such that the positive and negative feed-back voltages cancel one another out when the control bias applied to the control grid 11 of the auxiliary valve 10 is of minimum negative value. A suitable operating adjustment is one in which for a weak signal the net feed-back is zero. When a stronger signal is received the grid 11 of the auxiliary valve 10 will be biased more negatively, and, owing to the curvature of its characteristic curve, its gain is reduced and, therefore, the positive feed-back will be decreased, the balance of feed-back become negative, and the ratio of output to input reduced. Minimum over-all amplification will be obtained when the auxiliary valve 10 is biased completely to cut-off.

In a preferred arrangement shown in Fig. 2 the valve 1 i. e., the valve whose gain is to be controlled, has its cathode 4 connected through the usual capacity shunted automatic bias resistance combination 16 in series with a tuned circuit 5 to earth, the end of this tuned circuit remote from earth being connected through a similar capacity shunted bias resistance 17 to the cathode 9 of the auxiliary valve 10. The anode 2 of the valve 1 is connected to one of the output terminals 15 and is also connected to a source (not shown) of anode potential through a tuned circuit 18 which may contain in addition to the usual tuned variable condenser 19 a blocking condenser 20, the junction of condensers 19, 20, being earthed. A tapping point low down on the coil in the tuned circuit 18 is connected through a condenser 21 to the control grid 11 of the auxiliary valve 10 which grid is connected to a source (not shown) of gain controlling unidirectional potential through a resistance 14. The anode 13 of the auxiliary valve 10 is connected to the positive terminal of the source of anode potential, and suitable positive bias is applied to the screen grid of the main valve, if this be of the screen grid type as shown in Fig. 2. A tuned circuit 8 is connected between the control grid 7 of the main valve 1 and earth (the input connections to this tuned circuit being preferably "tapped down" on the coil thereof as before) and the tuning condensers or other tuning reactances in the three tuned circuits 8, 5 and 18 are all uncontrolled.

With this circuit the anode resistance of the main valve (apart from that of the feed-back impedance) is high, but since the grid of the auxiliary valve is "tapped down" the voltage swings upon both valves may be kept very small. The maximum voltage magnification of the main valve 1 with respect to the grid circuit of the auxiliary valve is reduced to unity for the purpose of feeding the said auxiliary valve—which is solely a control valve—and at the same time by taking the output voltage from across the whole of the anode load resistance of the main valve (the output terminals are the anode of the main valve and earth) a large overall output voltage is obtainable.

It has been found experimentally, when using triodes of high "slope" of characteristics for the main and auxiliary valves, that a range of control of approximately 60 decibels is readily obtainable

with the main valve used as the first valve of a radio receiver.

What I claim is:

1. In a signal transmission system, a tube provided with at least a control grid, a cathode and an output electrode, an impedance connected to the cathode of said tube, a signal source connected between a control grid and the point on said impedance such that the signal voltage developed across the impedance by current flow of said tube is impressed in degenerative phase between said control grid and cathode, a second tube having at least a cathode, control grid and output electrode, means coupling the second tube control grid to the output electrode of said first tube, means connecting the cathode of the second tube to the cathode side of said impedance whereby the space current of said second tube flows through said impedance and develops signal voltage thereacross which is impressed between the control grid and cathode of the first tube in regenerative phase, a signal output circuit connected solely between the output electrode and cathode of the first tube, and means for varying the gain of said second tube in response to received carrier amplitude variations.

2. A method of receiving modulated carrier waves which includes the steps of amplifying collected waves, deriving alternating current voltages from amplified waves, impressing one of the voltages in degenerative phase upon the amplifier input, impressing a second of the voltages upon said amplifier input in regenerative phase, and controlling the relative magnitudes of the two voltages in response to carrier wave amplitude variations.

3. In combination with a signal amplifier having input and output electrodes, an impedance in the space current path of said tube, means for applying the alternating current voltage developed across said impedance in degenerative phase between the input electrodes of the tube, means for applying signals to said input electrodes, a second tube having said impedance in its space current path, means for applying signals derived from the output of said first tube between the input electrodes of the second tube, a signal output circuit coupled solely to the output electrodes of the first tube, and means for controlling the gain of the second tube.

4. In combination with a signal amplifier having input and output electrodes, an impedance in the space current path of said tube, means for applying the alternating current voltage developed across said impedance in degenerative phase between the input electrodes of the tube, means for applying signals to said input electrodes, a second tube having said impedance in its space current path, means for applying signals derived from the output of said first tube between the input electrodes of the second tube, a signal output circuit coupled solely to the output electrodes of the first tube, and means for controlling the gain of the second tube, said impedance including a resonant circuit tuned to the operating signal frequency.

5. In combination with a signal amplifier having input and output electrodes, an impedance in the space current path of said tube, means for applying the alternating current voltage developed across said impedance in degenerative phase between the input electrodes of the tube, means for applying signals to said input electrodes, a second tube having said impedance in its space current path, means for applying signals

derived from the output of said first tube between the input electrodes of the second tube, a signal output circuit coupled solely to the output electrodes of the first tube, and means for controlling the gain of the second tube, said last controlling means including a signal rectifier.

5 6. In combination with a signal amplifier having input and output electrodes, an impedance in the space current path of said tube, means for
10 applying the alternating current voltage developed across said impedance in degenerative phase between the input electrodes of the tube, means for applying signals to said input electrodes, a

second tube having said impedance in its space current path, means for applying signals derived from the output of said first tube between the input electrodes of the second tube, a signal output circuit coupled solely to the output electrodes of the first tube, and means for controlling the gain of the second tube, each of said tubes including signal tuned circuits between its input electrodes, said impedance consisting of a resonant circuit tuned to the operating signal frequency.

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