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AUTOMATIC VOLUME CONTROL DEVICE

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Fig. 1

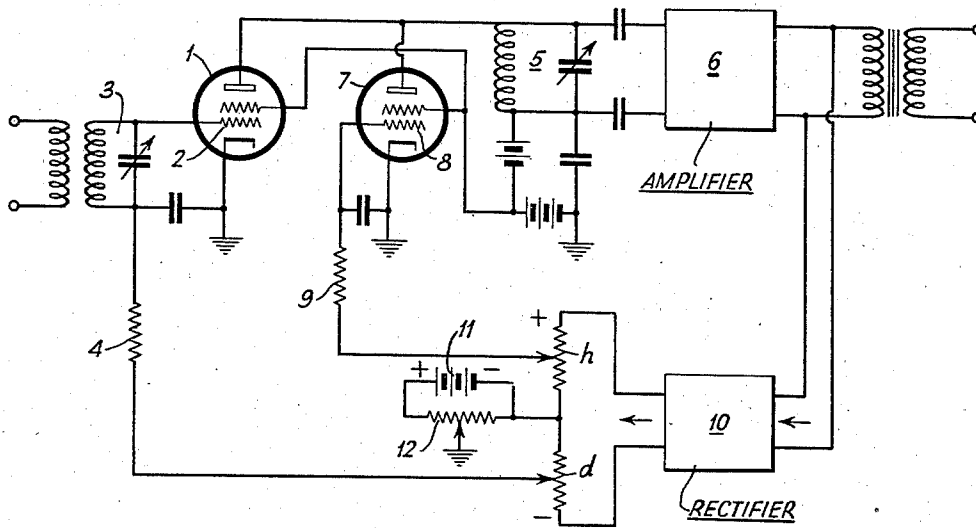
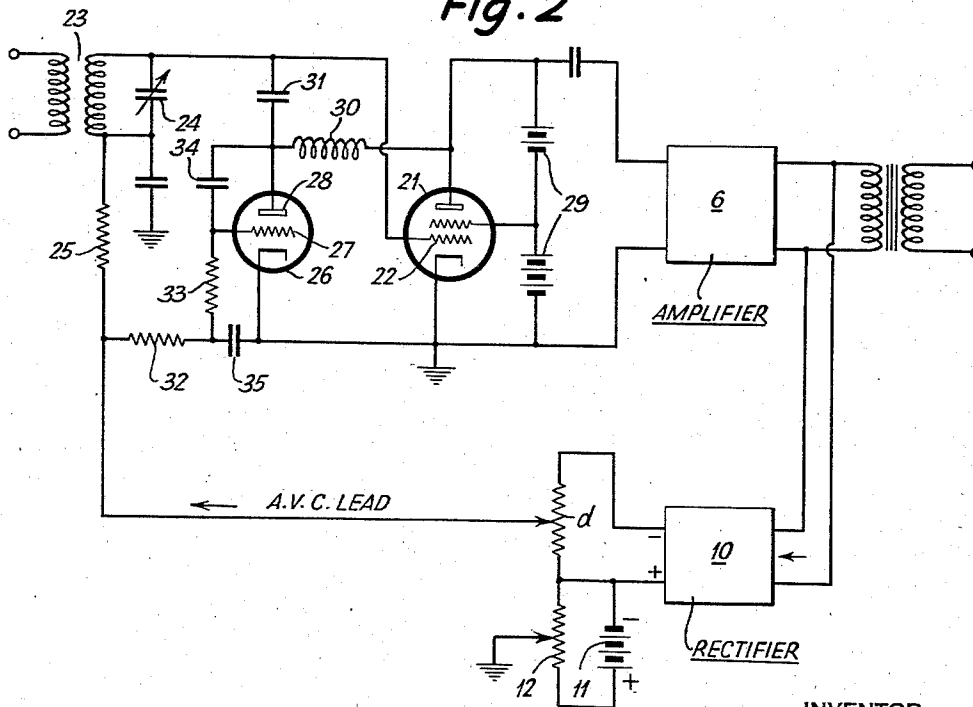


Fig. 2



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AUTOMATIC VOLUME CONTROL DEVICE

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4 Claims. (Cl. 179-171)

In some directional receivers, for instance, receiver systems comprising a plurality of directional antennae for short wave transoceanic reception, an amplitude-controlled RF, IF, or AF amplifier is required in which the phase between the input potential and the output potential remains constant for the entire control range, that is, for all amplifications. This is difficult to achieve because of the fact that during the control action the internal resistances of the amplifier tubes and possibly also their capacitances fluctuate with variations in the space charge. The effect of the control action, or regulation of the grid biasing potential, alters the tube characteristics and thus the phase, particularly if tuned grid and plate circuits are employed, as is usually the case in IF and RF amplifiers. On the other hand, the slightest phase variation between the signal energies brought together from a number of receiving antennae and associated receives results in very unsatisfactory distortion. This is especially noticeable in navigation systems and long distance short wave systems such as the Musa system.

Conditions must thus be made so that even very small phase shifts do not occur in the receiver. It is, therefore, an object of my invention to provide means for preventing the occurrence of phase shifts as far as possible, and throughout the entire control range.

It is another object of my invention to provide means for avoiding large amplitude variations in the medium and short wave bands of reception, and, generally speaking, to overcome the effects of fading phenomena.

According to the invention, in a directional receiver having an automatic volume control device for regulating the amplification of the tubes, I provide an auxiliary tube the plate-cathode path of which is connected in parallel relationship to the plate-cathode path of each tube which is to be regulated by means of a volume control potential. The control grid of this auxiliary tube is variably biased in a sense opposite to that of the usual A. V. C. circuit. The control bias is so chosen as to avoid variation in the total internal resistance of the tubes connected in parallel. The result is that a phase shift of the output potential with respect to the input potential is precluded.

My invention will now be described in more detail, reference being made to the accompanying drawing wherein

Figure 1 shows one form of circuit organization; and

Fig. 2 shows a modification.

Referring first to Fig. 1, an amplifier tube 1 has its control grid 2 connected to a source of RF potential to be amplified, this potential being fed through the tuned circuit 3. The volume control potential is fed by way of resistance 4 to the lower point of the oscillatory circuit, as is usual. The amplifier tube 1 has a plate-cathode path connected to the tuned circuit 5 which is coupled to the grid circuit of the following stage 6. If desired, an input rectifier for an RF or IF stage may be connected with circuit 5, although this has not been shown in the drawing.

In parallel relationship to the plate-cathode path of tube 1 is connected another tube 7 which of itself acts like a variably controlled resistance. The control grid 8 is connected through resistor 9 to a potentiometer *h* the voltage drop across which depends upon the output potentials from the amplifier 6 after rectification in the device 10. This same device also supplies rectified potentials to the potentiometer *d*. The junction between potentiometers *d* and *h* is connected to the negative side of a direct current biasing source 11. A potentiometer 12 is connected across the terminals of the source 11 and has a grounded tap for adjusting the steady D. C. bias on the two grids 2 and 8.

The A. V. C. action on grid 2 of tube 1, as obtained through the tap on potentiometer *d* is exactly opposite to that which is applied to grid 8 of tube 7, since the grid 8 derives its control bias from the tap on potentiometer *h*. What is thus obtained is that, for instance, with increasing internal resistance of tube 1, the internal resistance of tube 7 decreases. The same holds true as far as a possible capacitance variation of the plate-cathode paths in the two tubes 1 and 7 is concerned. In other words, the capacitance variations of these two tubes are caused to vary in an opposite sense.

The circuit organization of the invention may be carried into practice, for instance, by choosing tubes 1 and 7 of the same type. It can then be easily understood that for small amplification variations the required symmetric variations of the internal resistances and capacitances of tubes 1 and 7 are actually fulfilled. But for large control ranges it is not always possible to obtain or even to expect symmetric variations of the tube characteristics. For this reason tube 7 is either chosen of such type in comparison to tube 1 that in proximity to a certain grid biasing point the characteristics are symmetric in opposite senses. As an alternative, it may be desirable to choose values for the resist-

ances d and h , and to adopt tubes the properties of which differ in such a manner that symmetric compensation in opposite senses results.

Variable resistance 12 serves for the joint zero-point shifting of the basic grid biasing potentials of both tubes.

Referring now to Fig. 2, I show a modification in which the discharge tube 21 is provided with a novel input circuit arrangement designed to compensate for variations in its grid-cathode capacitance. This input circuit leading to the grid 22 derives signal potentials across the transformer 23 the secondary of which may be tuned by means of the variable capacitor 24. The D. C. bias potential for the grid 22 is derived through resistor 25 and potentiometer d one end of which is connected to the negative side of the D. C. source 11. This source has connected across its terminals a potentiometer 12 having an adjustable grounded tap, the same as shown in Fig. 1 and for the same purposes.

In parallel with the signal input circuit arrangement for the tube 21 I provide a space discharge path consisting of a discharge tube 26. This tube has a grounded cathode, a grid 27, and an anode 28 fed with positive D. C. potential from the D. C. source 29 through the choke 30. The anode 28 is also coupled across capacitor 31 to the grid 22 of the tube 21.

The tap on potentiometer d is connected to one end of resistor 32. Resistors 32 and 33 are interconnected and their junction is coupled across capacitor 35 to the grounded cathode of tube 26. The grid 27 is connected to the junction between resistor 33 and capacitor 34. The other side of this capacitor is connected to the anode 28. The plate to cathode impedance of tube 26 is caused to simulate a capacitance by employing the phase shifter 34-33. The condenser 31 applies signal potential to plate 28. The phase shifter causes the signal potential across resistor 33 to be in phase quadrature with the plate potential. The A. V. C. bias applied, through resistors 32 and 33, to grid 27 controls the amplification of tube 26. The essentially capacitive plate to cathode impedance of tube 26 is in shunt with the grid to cathode capacitance of tube 21. The plate to cathode capacitance of tube 26 varies inversely in magnitude relative to the grid to cathode capacitance of tube 21 in response to changes in magnitude of the A. V. C. bias derived from d .

The A. V. C. lead, as will be noted, is preferably connected both to the grid 22 of tube 21, across resistor 25, and to the grid 27 of tube 26, across resistors 32-33. The A. V. C. action may, however, be made the same or different with respect to the two tubes, the necessary adjustment being provided by the selection of values for the two resistors 25 and 32 respectively. Hence the most favorable characteristics or working points of the two tubes may be obtained for insuring exact compensation. For example, when the negative volume control potential increases, the grid-cathode capacitance of tube 21 tends to increase as a result of the increased space charge, while the capacitance acting between the plate and cathode of tube 26 decreases with a leveling off of the characteristic slope in this tube.

I claim:

1. In combination with a source of high frequency signal voltage, an amplifier tube having a tuned input circuit coupled to said source,

means responsive to signal amplitude variations for varying the gain of said amplifier tube, means for compensating for variations in tube input capacitance caused by said gain variation, said compensating means comprising an electron discharge device having at least a cathode, anode and control element, means connecting the cathode to anode impedance of said device in parallel to said amplifier input circuit, means for applying to said control element alternating potential which is in substantial phase quadrature with the anode alternating potential of said device thereby to cause said impedance to simulate a capacitance, and a connection from said control element to said gain varying means whereby the simulated capacitance and said input capacitance vary in inverse senses.

2. In a wave amplifier of the type including a tube provided with at least a cathode, signal grid and anode, the method including applying signal voltage to said tube, adjusting the gain of the tube in response to signal amplitude variations, deriving from the applied signal voltage a second signal voltage in phase quadrature therewith, establishing an electronic impedance between said grid and cathode, utilizing said quadrature voltage to cause said impedance to simulate a reactance, and varying the magnitude of said impedance in response to said signal variations in a sense to have the simulated reactance compensate for a shift of grid to cathode capacity shift arising during gain adjustment of said tube.

3. In combination with a source of alternating current voltage, a first tube having an input circuit coupled to said source, means for regulating the gain of said tube thereby causing an undesirable change in input capacity of said tube, means for compensating for said undesirable change comprising a second tube whose plate to cathode impedance is effectively in parallel with said input circuit, means for applying to a control element of the second tube alternating current voltage derived from said source but in substantial phase quadrature with the alternating voltage at the plate of the second tube thereby to cause said impedance to simulate capacitance, and means for varying the gain of the second tube in a sense such as to cause the simulated capacitance-magnitude to vary inversely to said undesirable capacity change.

4. In combination with a source of alternating current voltage, a first tube having an input circuit coupled to said source, means for regulating the gain of said tube thereby causing an undesirable change in input capacity of said tube, means for compensating for said undesirable change comprising a second tube whose plate to cathode impedance is effectively in parallel with said input circuit, means for applying to a control element of the second tube alternating current voltage derived from said source but in substantial phase quadrature with the alternating voltage at the plate of the second tube thereby to cause said impedance to simulate capacitance, and means for varying the gain of the second tube in a sense such as to cause the simulated capacitance-magnitude to vary inversely to said undesirable capacity change, said last varying means being common to said gain regulating means, and the latter being responsive to intensity changes in said source voltage.

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