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VARIABLE GAIN AMPLIFIER

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FIG. 1

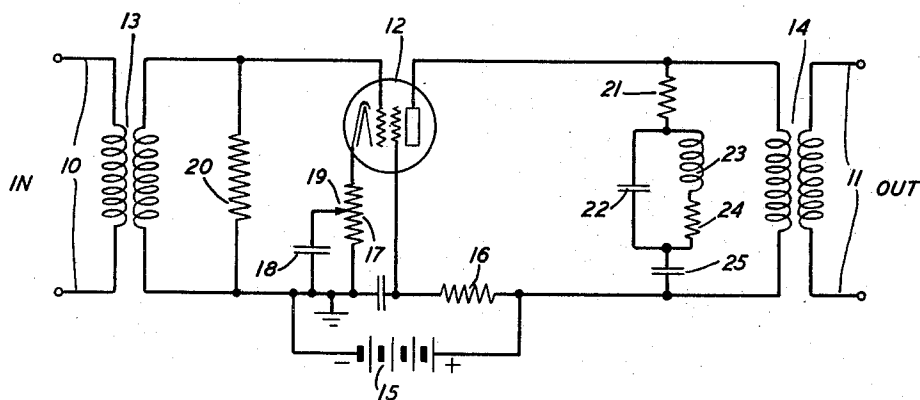
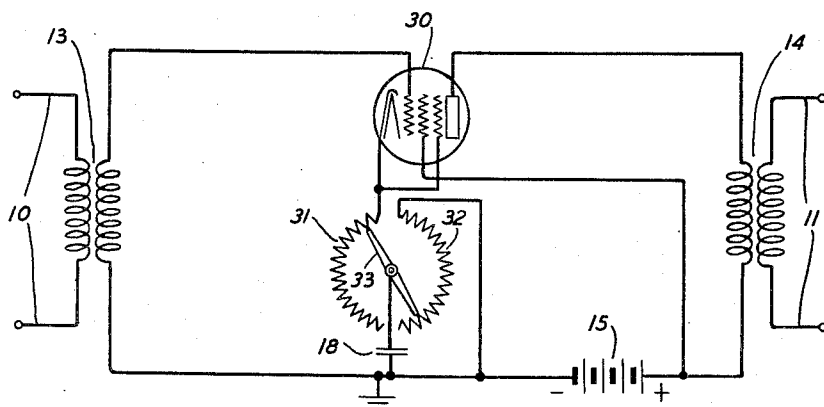


FIG. 2



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VARIABLE GAIN AMPLIFIER

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6 Claims. (Cl. 179—171)

The present invention relates to amplification of electrical waves, especially of waves comprising a band of frequencies, with provision for varying the amount of the amplification.

In amplifiers generally, and particularly where waves of a band of frequencies are to be amplified, the amplifier characteristic is dependent upon a number of factors entering into the circuit design. Consequently a change made in some circuit element in order to control the gain is liable to result in changing the characteristic in some undesired manner.

It is a general object of the present invention to enable the gain of an amplifier to be varied at will within practical limits while maintaining desired amplifier characteristics at the different gain adjustments.

Other objects and the various features and aspects of the invention will be apparent from the following detailed disclosure of a specific embodiment as illustrated in the attached drawing in which Figs. 1 and 2 show alternative forms of embodiment of the invention in amplifier circuits.

In the drawing, in each figure, a single stage of amplification is shown between the input circuit 10 and the output circuit 11, although it will be apparent that a plurality of stages of generally similar type may be used in tandem.

The amplifier tube 12, Fig. 1, is shown as a screen grid tube known as the Western Electric Company No. 259-A, although any other suitable type can be used. The grid circuit and plate circuit are respectively connected to the input and output circuits by transformers 13 and 14. The cathode is heated by passing current from a suitable source (not shown) through the heater element shown.

Anode potential, screen potential and grid bias are obtained from the 130 volt source 15, shown specifically as a battery, the screen lead including a resistor 16 of 100,000 ohms and the cathode lead including resistor 17 of 1,000 ohms from which the grid bias is derived.

Shunting a variable part of the resistor 17, in accordance with the invention, is a four microfarad condenser 18 shown connected to resistor 17 by a variable tap 19, for important purposes to be described later on.

Various elements are shown in the circuit for enabling the desired characteristic to be realized. A 600,000 ohm resistance 20 is connected in shunt of the secondary input coil, which has a step-up impedance ratio of 600 to 600,000 ohms. Shunting the output primary is a branch comprising a 60,000 ohm resistance 21, a parallel combination of

condenser 22 (.0159 microfarad), inductance 23 (0.152 microhenry) and resistance 24 (700 ohms) and series condenser 25 (.020 microfarad). The output coil works between 60,000 ohms and 600 ohms output circuit. These various circuit elements result in a gain that is flat within ± 0.015 decibel from 200 to 3400 cycles, the maximum gain being 37 decibels.

The variable tap on resistor 17 provides a simple and effective gain control which offers several advantages. The maximum gain (37 decibels) is obtained when condenser 18 shunts the whole of resistor 17. As the tap 19 is moved downward (in the figure) along resistor 17, however, a drop of potential at the signal frequencies is developed in the unshunted portion of resistance 17 and is applied to the grid circuit in such manner as to lower the amplifier gain. In the example given, the gain may readily be reduced in this way by as much as 8 to 10 decibels.

By this method of gain control, the amplifier characteristic remains substantially unaffected. It is substantially flat between the limiting frequencies given at all settings of slider 19.

It will be noted that this method of gain control does not affect grid bias or normal plate current or amplifier impedance, but rather affects directly the resultant signal voltages. Thus, sudden changes in the gain adjustment do not set up clicks such as are caused by changes in normal plate current.

As the gain is reduced by the method described, the distortion is decreased as is also any noise originating in the amplifier circuit. This is because the reduction in the gain is produced by a negative feedback action whereby new frequency components first appearing in the amplifier output are reduced in magnitude. Also as the gain is reduced by this method, the amplifier gain is stabilized with respect to changing battery or other voltages.

The general method of negative feedback for improving amplifier operation is the invention of H. S. Black and is claimed by him in another application.

Referring to Fig. 2 a modified form of circuit for practising the same general method of gain control is shown. In this figure while, as before, any suitable type of tube may be used, a pentode tube is shown by way of example having its second screen connected to the positive terminal of the plate battery 15. The transformers 13 and 14 may be shunted if desired as in Fig. 1 or otherwise to improve the over-all characteristic,

or an entirely different type of coupling may be used for input and output circuits, as desired.

The main point of difference over Fig. 1 lies in the use of a divided resistance 31, 32 through which the space current flows for bias purposes. As the arm 33 is rotated, the shunting condenser 18 is made to shunt a variable part of the total bias resistance as in the case of Fig. 1 but the total bias resistance remains unchanged. This is true because the arm 33 adds as much resistance to the circuit on one side as it subtracts from the other, keeping the total a constant.

One advantage of the type of controller shown in Fig. 2 is that the space current flows through the variable contacts of the resistance 31, 32, which results in a quieter circuit in some circumstances. If a high resistance develops at a contact point because of oxidation, dirt or dust, for example, a high voltage builds up across the contact, which may amount to the full voltage of battery 15, and this voltage tends to break down the film and restore the circuit conditions to normal. If a high resistance develops at the contact 19 of Fig. 1 the effect is to add this resistance to the shunt resistance of condenser 18 and this may change the gain or the characteristic or introduce noise since the contact resistance may be variable.

In the foregoing description specific information has been given of a preferred embodiment. It is to be understood that these data are given by way of example in order readily to enable one skilled in the art to make and use the invention, but that the magnitudes of quantities given in no wise limit the invention, which is defined in the claims. The type of tube, type of circuit, frequency range and other matters are capable of wide variation within the invention.

What is claimed is:

1. In an amplifier circuit, a space discharge device having anode and grid or impedance control circuits, resistance common to the grid and anode circuits for applying a negative bias potential to the grid, input and output connections for the waves to be impressed on and derived from said device, and means to control the gain of said circuit comprising a path opaque to direct current but of negligibly low impedance to said waves connected in shunt to a variable portion of said resistance.

2. In an amplifier circuit for amplifying waves of a band of frequencies, an amplifier having an input circuit and an output circuit for said waves,

an input or control element, an anode, resistance common to the input and output circuits for impressing on the input or control element, voltage produced in said resistance by flow of output circuit current of both direct current and of current representing said waves, and means to control the gain of said circuit comprising means to control the voltage produced in said resistance by currents representing said waves while keeping constant the voltage produced therein by flow of direct current.

3. In an amplifier circuit for waves to be amplified, a space discharge device having a cathode, an anode and a grid or control element, a source of anode potential having a negative terminal 15 connected through a resistor to the cathode and a positive terminal connected to the anode, a grid-to-cathode connection including said resistor, input and output connections for the waves being amplified, a path of high impedance to direct current but of negligibly low impedance to currents of the frequency of the waves being amplified connected in shunt of said resistor, and means to vary the gain comprising means to vary the amount of said resistor that is shunted by said path.

4. In the operation of an amplifier of the type in which the grid bias is obtained from drop-of-potential in plate circuit resistance, the method of controlling the gain comprising varying the amount of said resistance that is traversed by waves being amplified while keeping unchanged the amount of said resistance that is traversed by direct current.

5. An amplifier circuit of the type in which the negative grid bias is obtained from resistance common to the grid and anode circuits, which resistance is shunted by a condenser, characterized by means to control the gain of the amplifier without changing the grid bias, comprising means for varying the amount of the bias resistance that is shunted by the condenser.

6. A circuit according to claim 5 in which said bias resistance is made in two parts with a movable tap on each part, said taps being connected together electrically and mechanically to move together to vary in complementary manner the amount of each part of the resistance that is included in circuit, said condenser being connected from said taps to the negative end of said resistance.

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