April 24, 1945. P. GLASS 2,374,480

SELF-COMPENSATING AMPLIFIER TUBE CIRCUIT

Filed Jan. 26, 1943

Fig. 1.

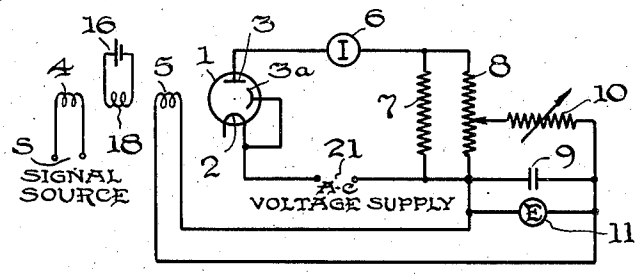


Fig. 2.

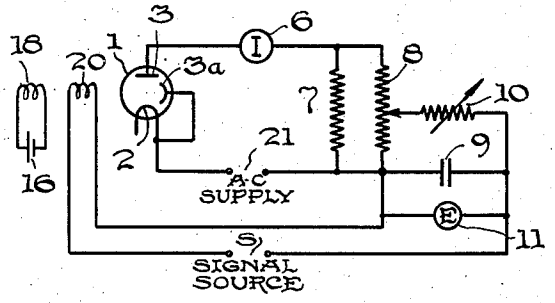
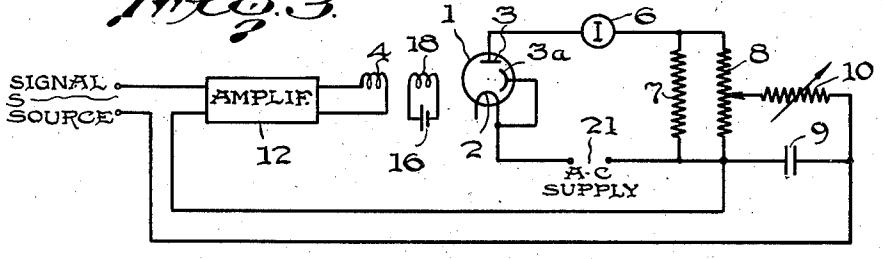


Fig. 3.



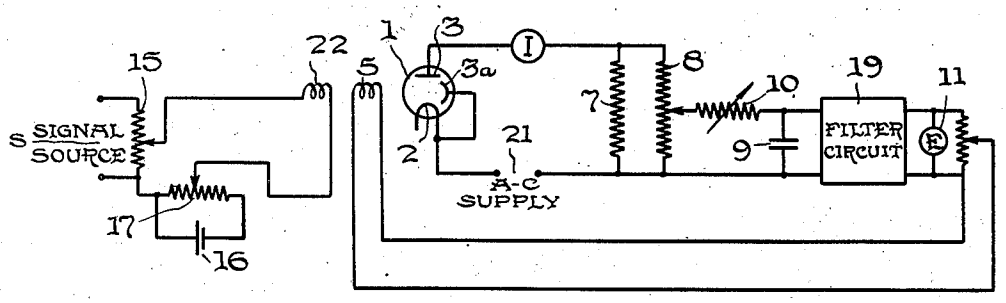


Fig. 4.

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SELF-COMPENSATING AMPLIFIER TUBE CIRCUIT

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10 Claims. (Cl. 179—171)

This invention relates to a novel self-compensating amplifier circuit for use in A. C. or D. C. translation or controlling devices. More particularly it relates to a magnetically controlled gas or vapor discharge tube, as for instance the tube which is known as the permatron. This type of tube is disclosed in Electrical Engineering, May 1939, volume 58, pages 224 to 228; see also Spencer Patent 2,124,682.

The advance of such a circuit is that it automatically compensates within the range of its characteristics for variations which are due to heater current variations, individual tube characteristics, and changes of tube performance which may be a function of time and variables, and which may affect the output of the tube in relation to the input signal.

This arrangement, and particularly the use of a gaseous types of tube in the circuit, has a great advantage in that it permits a control of considerable current with very small signals, or, in other words, great amplifications with definitely adjustable amplification factors.

Further aims and advantages of the invention will appear in the specification when considered in connection with the accompanying drawing, in which:

Figure 1 shows a self-compensating current amplifier with separate and independent feed back, embodying the features of my invention.

Figure 2 is a modified form of the invention shown in Figure 1 with a series circuit feed back.

Figure 3 is a modified form of the invention shown in Figure 2 embodying a signal preamplifier in the circuit.

Figure 4 shows another modification of the form of the invention shown in Figure 1.

As is well known, a considerable amount of current flows through a gaseous or vapor discharge tube of the permatron type. As soon as the magnetic field produced by the signal reaches a definite limit value, the tube then becomes conductive until such time as the tube current is interrupted by reversal of the alternating plate voltage or any other means of interrupting the circuit. In Fig. 1, 1 represents a tube of the permatron type with its filament or cathode 2, its anode 3, and its collector electrode 3a. 4 is the signal input coil arranged and disposed to impress on the tube 1 input signals derived from a source S. 15 is another coil of the magnetic system connected to a source 16 of biasing voltage of suitable magnitude and serving to deflect the electrons from cathode 2 onto collector electrode 3a. 5 is an additional coil arranged to counteract the magnetic field produced by the signal in said first coil 4 and energized from the output of the circuit, as will be described later.

The plate is connected through an ammeter 6 and a load (represented by resistance 7) to one terminal of an alternating voltage supply 21 of suitable and preferably high frequency, while the other terminal of said voltage source 21 is connected to the cathode 2. The voltage across the load resistor 7 is applied to a potentiometer 8 and an adjustable part of this voltage is applied to a condenser-resistance-network 9—10. The terminals of the condenser 9 are connected to the additional control coil 5. The polarity of the connections is such that the magnetic field produced by 5 is opposed to the field of coil 4 which is the result of the signal. A voltage meter 11 is connected across condenser 9.

Assuming that a signal, for instance a D. C. voltage, is applied to the controlling coil 4, the tube will fire during positive half cycles of the supply voltage and current will flow in the plate circuit, it being understood that in the absence of a signal the biasing field prevents the tube from firing. The result of this output or plate current will be a voltage drop across the load 7 which charges the condenser 9 through variable resistor 10 to a value which is determined by the adjustment of the potentiometer 8. The condenser discharges relatively slowly through control coil 5 and thereby produces a magnetic field counteracting or nullifying the effect of the magnetic field produced by the signal coil 4. As soon as the counteracting force produced by coil 5 is equal to that of the signal produced by coil 4, the tube fails to fire at the beginning of a positive half cycle of the supply voltage. The number of firing cycles and their ratio to the number of nonconducting cycles is thus automatically controlled by the circuit and a resultant average output current obtained which is directly proportional to the input signal. By choice of a suitable frequency of the plate voltage supply and the time constant of the condenser-resistance-circuit 9—10, the variations of the condenser voltage can be practically eliminated. By an adjustment of the potentiometer 8, different amplification ratios between input and output can be obtained.

In Fig. 2 a modification of the above circuit is shown, identical numbers designating identical parts. It will be noted that the condenser-resistance-network 9—10 is connected in series with and in opposition to the input signal source S and not separated as in Fig. 1. The joint effect

of the condenser-resistance-network 9—10 and the signal source are in this form applied to a coil 20 which serves the combined functions of the coils 4 and 5 in the form of the invention shown in Fig. 1.

In Fig. 3 an arrangement is shown which is suitable for relatively great amplifications of signal voltages, again identical numbers designating parts which were described in connection with Fig. 1. The difference as compared with Fig. 1 is that the signal voltage is applied to an amplifier 12 which produces the controlling current applied to the coil 4. The feed back circuit is similar to the one described in connection with Fig. 2 and is in series connection with and opposed to the signal source S. A separate coil 18 and voltage source 16 is provided for a suitable bias of the tube.

In Fig. 4 the circuit of Fig. 1 is modified by providing a filter circuit 19, as known in the art, in the output circuit of the tube, in order to smoothen out any variations of the output voltage which may appear across condenser 9. In this form of the invention, provision is made whereby the coils 4 and 18 of Fig. 1 may be replaced by a single coil 22. To that end, the coil 22 is connected in series with potentiometers 15 and 17. The signal source S is applied to potentiometer 15 and a constant biasing voltage from the voltage source 16 is applied to the potentiometer 17.

Obviously the present invention is not restricted to the particular circuits as shown and described, but said circuits are capable of various modifications.

I claim as my invention:

1. An amplifier circuit comprising, in combination, a magnetically controlled gaseous discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, means for impressing on said tube a signal to be amplified, means for placing a bias on said tube, and a circuit deriving its energy from said tube arranged to counteract the effect of a signal acting on said tube through said first mentioned means in such manner as to produce an output current substantially proportional to the input signal.

2. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, means for impressing on said tube a signal to be amplified, means for placing a bias on said tube, a potentiometer connected in parallel with said load, a condenser and a resistance connected in series across the variable portion of said potentiometer, and means connected across said condenser and arranged to counteract the effect of a signal acting on said tube through said first mentioned means in such manner as to produce an output current substantially proportional to the input signal.

3. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, a first coil for impressing on said tube a signal to be amplified, means for biasing said tube, means connected to said plate circuit to obtain an adjustable voltage, a resistance and a condenser connected in series across the adjustable portion of said last mentioned means, and a second coil connected across said condenser and disposed to impress its field upon said tube in a manner to counteract the effect of the field produced by said first coil when a signal is supplied thereto.

4. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, means for biasing said tube, a coil disposed to have its magnetic field impressed on said tube to exercise control thereover, a circuit for said coil including a signal source, means connected to said plate circuit to obtain an adjustable voltage, a resistance and a condenser connected in series across the adjustable portion of said last mentioned means, said condenser being also connected in the circuit for said coil in series opposition to said signal source.

5. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, means for biasing said tube, a coil disposed to have its magnetic field impressed on said tube to exercise control thereover, means connected to said plate circuit to obtain an adjustable voltage, a resistance and a condenser connected in series across the adjustable portion of said last mentioned means, a source for signals to be amplified, means connecting said condenser in series opposition to said signal source, and an amplifier for impressing the resultant signal effect on said coil.

6. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a load and an alternating current voltage source, a coil disposed to have its magnetic field exercise control over the operation of said tube, an energizing circuit for said coil including in series the variable portions of a first and a second potentiometer, said first potentiometer being adapted to have the signal to be amplified impressed thereon, a source of biasing potential impressed across said second potentiometer, means connected to said plate circuit to obtain an adjustable voltage, a resistance and a condenser connected in series across the adjustable portion of said last mentioned means, a second coil disposed to have its magnetic field exercise control over the operation of said tube, and means for connecting said second coil to receive its energization from said condenser and disposed to counteract the effect of the field produced by said first coil when a signal is supplied thereto.

7. An amplifier circuit comprising, in combination, a magnetically controlled gaseous discharge tube, a plate circuit for said tube including a series impedance element and a source of alternating current voltage, means for applying to said tube a biasing magnetic field to prevent firing of said tube in the absence of a signal, means controlled by input signals to cause firing of said tube, a condenser connected to be charged by the voltage drop across said impedance element, and a magnetizing coil energized from said condenser for acting on said tube in opposition to said input signals.

8. An amplifier circuit according to claim 7 wherein a resistance element is included in the charging circuit of said condenser.

9. An amplifier circuit according to claim 7 wherein a resistance element is included in the charging circuit of said condenser, and including a filter connected between said condenser and said magnetizing coil.

10. An amplifier circuit comprising, in combination, a magnetically controlled discharge tube, a plate circuit for said tube including a series impedance element and a source of alternating current voltage, magnetic means controlled by input signals to vary the flow of current in said plate circuit, a condenser connected to be charged by the voltage drop across said impedance element, and magnetic means energized from said condenser and acting on said tube to vary the plate current in opposition to said input signal.

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