

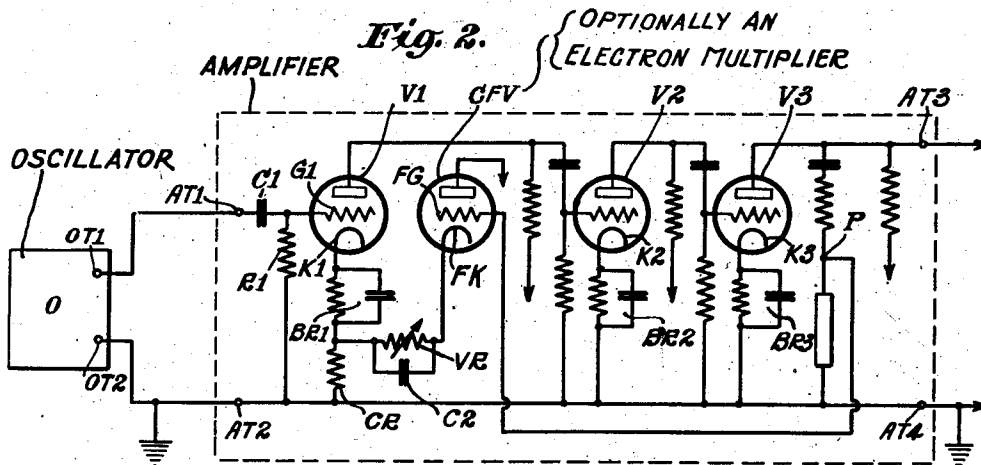
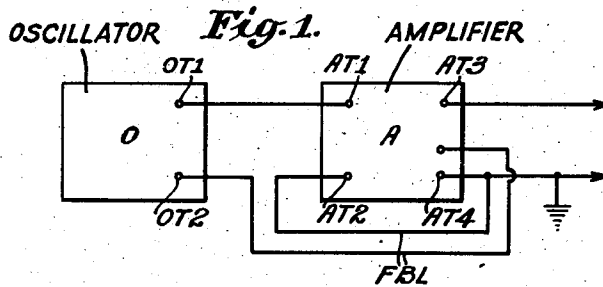
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FEEDBACK CIRCUIT ARRANGEMENT

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FEEDBACK CIRCUIT ARRANGEMENT

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This invention relates to electron discharge circuit arrangements and more particularly to circuit arrangements wherein voltage feed-back is employed.

The invention is illustrated in and explained in connection with the accompanying diagrammatic drawing, wherein Figure 1 illustrates by a block diagram a conventional feed-back circuit arrangement; and

Fig. 2 illustrates certain improvements which constitute the substance of my invention.

It is often required to provide voltage feed-back from one valve to a preceding valve in a chain of valves, for example, to improve the frequency characteristic of an amplifier including said valves. To mention but one of the numerous cases wherein voltage feed-back is required, an oscillator unit may be arranged to feed into a multi-stage amplifier unit, and in order to improve the frequency characteristic of the amplifier, or to reduce non-rectilinear distortion, it is a common expedient to provide a voltage feed-back circuit across the amplifier from, say, the last valve thereof to the first valve. The method at present usually employed for thus introducing voltage feed-back is illustrated in block diagram form in Figure 1.

Referring to Fig. 1 rectangle O represents an oscillator having output terminals OT1 and OT2, and rectangle A represents an amplifier having input terminals AT1, AT2 and output terminals AT3, AT4. Voltage feed-back is introduced by interrupting the earth connection which, were no feed-back provided, would normally directly connect the low potential output terminal OT2 of the oscillator unit O with the low potential input terminal AT2 of the amplifier A, in order to insert the feed-back line FBL. This expedient, though very commonly employed, has the serious disadvantage that, by reason of the break in the earth connection for the insertion of the feed-back line, only one of the two units—the oscillator and amplifier units—may be earthed. This defect is obviously a cause of inconvenience in practice, and especially so, since any capacity to earth of the first unit, the oscillator, is put in parallel with the feed-back line, thus producing deleterious effects upon the frequency characteristic of feed-back. There are known methods of applying voltage feed-back which avoid these disadvantages, but such known methods are complicated and introduce other compensating disadvantages.

According to this invention, voltage feed-back is effected between a point in a chain of electron

discharge devices and a preceding point by means of one or more electron discharge devices presenting high mutual conductance and employed to vary the impedance of a tube circuit of a preceding stage, particularly between the cathode and ground.

Preferably the cathode impedance common to the input and output circuits is an ohmic resistance, though it may be a reactance. The cathode impedance may also be controlled by an electron multiplier. Known electron multipliers are available having mutual conductances of the order of 40 milli-amperes per volt. Their use in carrying out this invention is, therefore, of substantial advantage. Ordinary tubes, though utilizable, do not as a rule have mutual conductances exceeding about $1/20$ of this value. As will be hereinafter explained, the higher the mutual conductance of the feed-back circuit, or cathode follower, the lower can be the value of the cathode resistance. With a cathode follower having a mutual conductance of the order of 40 milli-amperes per volt, a cathode resistance of as low as 10 ohms, may be employed. Again, as will be hereinafter explained, since this cathode resistance is common to the cathode circuit of the device at which voltage feed-back is effected, it will produce a certain measure of current feed-back in that device, but in general, the feed-back thus produced will be too small to be important. Any feed-back which is produced in this way, however, will result only in an improved frequency characteristic at the expense of a slight loss of gain.

Preferably provision is made for varying the effective feed-back by varying the mutual conductance presented by the cathode follower. Such mutual conductance variation may be effected in any suitable way, for example, by controlling one or more of the electrodes of the cathode follower, but a preferred way is to employ a condenser shunted cathode resistance and to vary the said resistance. This method of control has the advantage that the phase changing characteristics of the feed-back network are not varied appreciably with variation of the degree of feed-back. This is of particular advantage when the feed-back network is required to introduce a predetermined amount of phase shift.

Fig. 2 shows diagrammatically one embodiment of the invention as applied to an oscillator O and succeeding multi-stage amplifier arrangement, the latter being included within the dotted line rectangle. Referring to Fig. 2 the high potential output terminal OT1 of the oscillator O is re-

sistance-capacity-coupled by elements R1 and C1 to the control grid G1 of the first tube V1 of the multi-stage amplifier which incorporates in the example illustrated three resistance-capacity-coupled amplifier tubes V1, V2, and V3. The cathode K1 of the first stage tube V1 is connected to ground and to the low potential output terminal OT2 of the oscillator through a series circuit comprising a capacity shunted self-bias resistance unit BR1 and a cathode resistance CR of low value. Associated with the tube V1 is a cathode follower tube CFV, whose cathode FK is connected through a variable resistance VR shunted by a condenser C2 to the point between the self-bias resistance and the cathode resistance in the cathode leg of the valve V1. Preferably, though not necessarily, the cathode follower tube is an electron multiplier, but in any event it should have as high a mutual conductance as practicable. Voltage taken from a suitable point P in the anode circuit of the last tube V3 of the amplifier is fed to the control electrode FG of the cathode follower tube CFV. The cathodes K2, K3 of the second and third tubes V2, V3 of the amplifier A are grounded in the usual way, each through its own capacity shunted self-bias resistance unit BR2, BR3.

It will be seen that with this arrangement both the oscillator and the amplifier units may be grounded on the low potential side, despite the provision of voltage feed-back. Further, the degree of voltage feed-back is easily and efficiently controllable by varying the value of the resistance VR, which is common both to the follower tube CFV and to the first tube V1 of the amplifier.

If desired, instead of employing a single electron discharge device as the cathode follower, a number of devices operated in parallel, may be employed. By operating a number of tubes in parallel in this way, a high effective mutual conductance may be obtained for the cathode follower even if the individual tubes constituting said follower are not of very high mutual conductance.

Although the invention has been specifically described in connection with the application of voltage feed-back in an arrangement incorporating an oscillator followed by a multi-stage resistance capacity coupled amplifier, the invention is, of course, not limited to such application, but may be employed wherever voltage feed-back is desired.

I claim:

1. In combination with a plurality of successive electron discharge tube stages, a feed-back circuit arrangement comprising at least one dis-

charge tube having a high mutual conductance and having input and output circuits, said input circuit being coupled to the output side of a succeeding one of said stages, a cathode resistor connected between ground and the cathode of a discharge tube in a preceding one of said stages, and a connection from an intermediate point on said cathode resistor to the cathode of the tube in said feed-back circuit.

2. An amplifier system comprising first, second and third electron discharge tube stages, a feed-back circuit arranged to derive output energy from said third stage for control of the gain in said first stage, a resistor connected between the cathode of the first stage and ground, a capacitor shunting a portion of said resistor adjacent the cathode, said feed-back circuit being connected to the junction between the shunted and unshunted portions of said resistor, means including a discharge tube in said feed-back circuit for amplifying said feed-back energy, said discharge tube having a grid under control of said feed-back energy and a cathode connected to ground through a capacity-shunted resistor and thence through the unshunted portion of the first said resistor, and means for adjusting the degree of feed-back to an optimum value.

3. A system according to claim 2 wherein said discharge tube in the feed-back circuit is constituted as an electron multiplier.

4. A system according to claim 2 wherein the last said means is constituted by a device for varying the impedance of that resistor which is individual to the cathode circuit of said feed-back amplifier tube.

5. In a three-stage amplifier system, a feed-back circuit arrangement comprising means for amplifying the feed-back energy derived from the output side of the third stage for controlling the gain in the first stage, said means comprising a discharge tube of the electron multiplier type wherein there is a grid under control of said output energy from the third stage and a cathode connected to an intermediate point on a cathode resistor provided for the tube in said first stage, and adjustable means including a variable resistor in the cathode circuit of said electron multiplier tube for varying the degree of feed-back without appreciably disturbing the phase of the feed-back energy applied to said first stage.

6. The combination according to claim 1 in which said discharge tube in the feed-back circuit is constituted as an electron multiplier.

7. The combination according to claim 1 in which the last mentioned connection is resistive.

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