

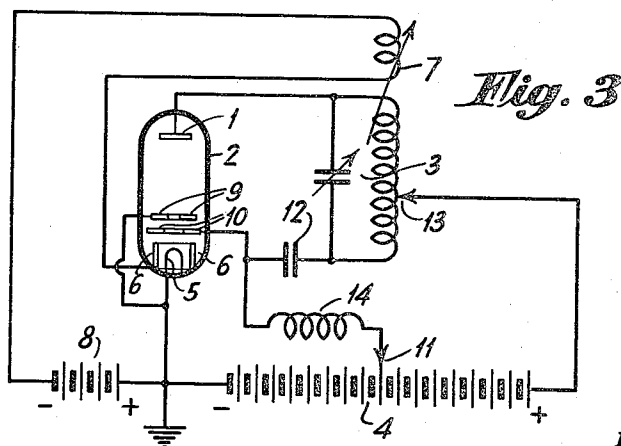
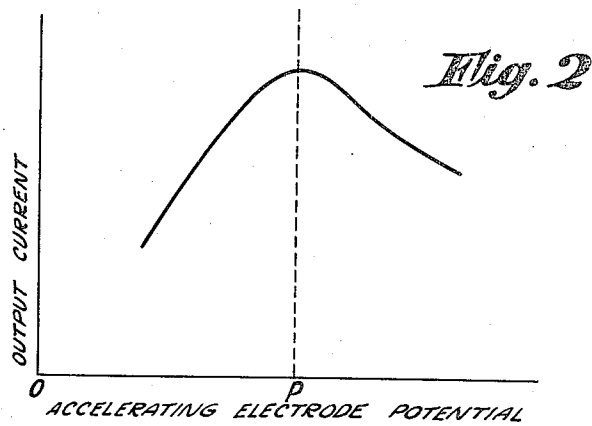
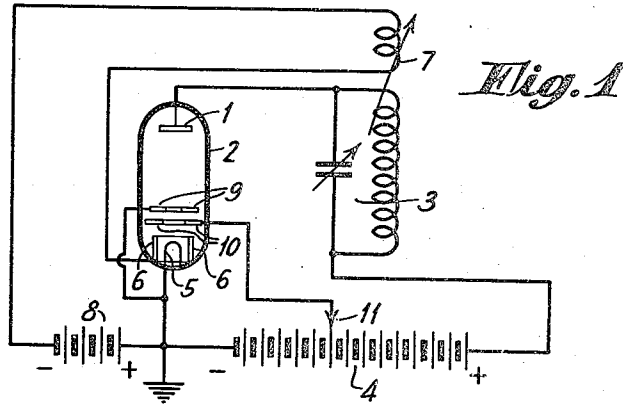
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THERMIONIC VALVE CIRCUIT ARRANGEMENT

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THERMIONIC VALVE CIRCUIT ARRANGEMENT

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This invention relates to thermionic valve circuit arrangements and more particularly to circuit arrangements employing thermionic valves of the type now known as electron beam valves, i. e., of the type wherein the electron discharge is in the form of a jet or beam rather than in the form of a stream and partakes more of the nature of the discharge in a cathode ray tube than of that in an ordinary thermionic valve as at present in common use. Electron beam valves are described in the British Patent No. 403,973 among others.

The main object of the present invention is to provide an improved electron beam valve circuit arrangement wherein controllable reaction may be obtained. The obtaining of controllable reaction is often required, for example in radio receiving sets, for the purpose of increasing selectivity and/or increasing amplification.

The invention is illustrated in and explained in connection with the accompanying diagrammatic and graphical drawing in which Fig. 1 shows a conventional circuit as an aid to explaining the invention; Fig. 2 shows graphically the relationship between amplification and accelerator voltage of a cathode beam tube; and Fig. 3 shows one embodiment of the invention.

If an electron beam valve be connected in an ordinary back coupled reaction circuit certain difficulties which will be described later herein arise. Consider, first the circuit shown in Figure 1 which is an explanatory figure and represents a circuit which is not in accordance with the present invention. Referring to Figure 1, the target or collector electrode 1 of an electron beam valve 2 is connected through the usual output parallel tuned circuit 3 in series with a source 4 of anode voltage to the cathode 5 and the control electrode 6 is connected to the cathode 5 through a reaction coil 7 (which is coupled to the coil in the output circuit 3) in series with a bias battery 8. The guard electrode 9 of the valve 2 is connected to the cathode 5 directly (the guard electrode 9 is provided for the purposes of minimizing secondary emission effects and providing screening) and the accelerator anode 10 is connected to a suitable point 11 upon the anode potential source 4. This circuit arrangement constitutes the ordinary well known inductive feed back reaction circuit applied to an electron beam valve. If in this circuit arrangement the coupling between the reaction coil 7 and the coil in the output circuit 3 be varied it will be found that smooth and gradual control of the reaction (such as is obtainable with this circuit when employed with an ordinary

valve) up to a point where the circuit reaches self-oscillation is not readily obtainable but that adjustment of the coupling is very critical (especially when near the self-oscillatory condition) so that in practice it is almost impossible to bring the circuit to a point near the self-oscillatory condition with reasonable certainty that the circuit will not suddenly burst into self-oscillation. The reason for this difficulty is to be found in the characteristics of the electron beam valve as distinct from the characteristics of an ordinary valve. In the first place the impedance of the target or collector electrode circuit of an electron beam valve is very high—being usually many megohms—and the target-gun space of the valve imposes no appreciable damping on the tuned circuit in the target circuit. In consequence, therefore, as the coupling between the reaction coil and the output coil increases, a point is reached when the whole arrangement suddenly bursts into self-oscillation of such a magnitude that the control electrode becomes positive to the cathode at the limit of its swing. Accordingly current flows in the control electrode circuit and the presence of this current damps the increasing oscillation in the output tuned circuit via the coupling between said tuned circuit and the reaction coil, and a steady state finally results wherein substantially constant oscillatory current flows in the output tuned circuit. Now, as is well known, one of the most important uses of reaction in a receiving circuit is for the reduction of the effective damping of an oscillatory circuit to a very low value. If with an electron beam valve connected in the known reaction circuit of Figure 1, such reduction of effective damping was sought to be obtained by increasing the coupling between the reaction coil and the output coil, a point would soon be reached where quite a small chance disturbance or transient would be sufficient to cause the whole arrangement to burst into self-oscillation, the oscillations building up with great rapidity to the limiting value already referred to.

With a normal triode in the known reaction circuit of Figure 1 the ordinary curvature of characteristic is sufficient to avoid this critical or unstable condition, for the curvature of the anode characteristic of an ordinary triode is such that the presence of an oscillation slightly reduces the over-all magnification of the valve. The result is that when using the known reaction circuit of Figure 1 with an ordinary valve it is possible by careful adjustment of the coupling between the reaction coil and the output coil to maintain weak oscillations of desired amplitude in the output

circuit and indeed to keep the whole arrangement in a condition of very nearly zero effective resistance by suitable critical adjustment of the reaction coupling and of the applied voltages. Where, however, an electron beam valve is used in the same circuit arrangement, low effective damping is very difficult, if not impossible, to secure, for the target characteristic of such a valve is a substantially straight line parallel to the target voltage axis of the curve.

The present invention avoids the difficulties above referred to and enables an electron beam valve to be operated in a sensitive and controllable reaction circuit to give controllable reaction up to the point of self-oscillation and enables oscillations of controllable magnitude—including quite weak magnitudes—to be generated.

According to this invention a reaction circuit arrangement employing an electron beam valve is characterized in that a component of oscillatory voltage from the output circuit of the valve is fed back to the accelerator electrode of the valve.

Figure 2 is a graph connecting the output current (ordinates) of an electron beam valve operated without reaction and the accelerator electrode voltage (abscissae) and it will be seen that the said curve has a fairly well defined though not sharply peaked maximum value at P. The present invention makes use of this property of electron beam valves to enable smoothly controllable reaction to be obtained.

Figure 3 shows one way of carrying out this invention. Referring to Figure 3 an electron beam valve 2 has an output tuned circuit 3 connected at one end to the target 1 and at the other end through a suitable coupling condenser 12 to the accelerator anode 10. A tapping point 13 upon the coil in the output tuned circuit 3 is connected through a source 4 of target potential to the cathode 5 and a tapping point 11 upon this source is connected through a high frequency choke 14 to the accelerator anode 10. The guard electrode 9 is directly connected to the cathode 5 and the control electrode 6 is connected through a reaction coil 7 in series with a bias source 8 to the cathode 5. The reaction coil may be adjustably coupled to the output coil as in the usual way.

As a preliminary suppose that the tapping 13 upon the output coil is central. This tapping is maintained at a steady potential by the target potential source 4 and since the accelerator anode 10 is capacity coupled through condenser 12 to one end of the output coil, the said accelerator anode 10 will swing in voltage by half the total potential swing across the output tuned circuit 3. If the potential applied to the accelerator anode 10 has been set to the optimum voltage (as given by the curve of Figure 2) the amplification of the valve will swing to and fro about the maximum, and its mean value will be less than if the potential on anode 10 were maintained steady at the optimum value, the exact amount of the reduction of magnification depending upon the amplitude of the oscillations and of the shape of the curve above referred to. It will be apparent therefore that stable and smooth reaction conditions will be obtained for immediately any oscillation is set up in the output circuit 3 the oscillation "build up" will be controlled by the effective reduction of amplification of the valve. The intensity of this control may be adjusted by varying the position of the tapping 13 upon the output coil, the near-

er this tap is to the accelerator anode and of the output coil the less being the said control.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A reaction circuit arrangement comprising an electron beam valve having a cathode, a control electrode, an accelerating and focusing electrode for forming electrons from the cathode into a beam, and a target electrode, an output circuit connected at one end to the target electrode of said valve and at the other end through a condenser to the accelerating and focusing electrode of said valve, a connection including a source of target potential, between the cathode of said valve and an intermediate point on said output circuit, a connection including a reaction coil and a bias potential source between the control electrode of said valve and said cathode, said reaction coil being coupled to said output circuit, and a connection including a choke between said accelerating and focusing electrode and an intermediate tap on said source of target potential whereby energy fed from the output circuit to said accelerating and focusing electrode reduces the effective amplification factor of the tube.

2. An arrangement as claimed in claim 1 wherein the intermediate point on the output circuit is adjustable.

3. In an oscillating circuit wherein is provided an electron beam tube having a cathode, control electrode, an accelerating and focusing electrode, a target electrode, and a resonant circuit, the method of improving the control of oscillations which comprises the steps of focusing electrons from the cathode into a beam, projecting the beam toward the target electrode to produce oscillations in the resonant circuit, and feeding back energy from the resonant circuit to the accelerating and focusing electrode in anti-phase relation whereby the effective amplification of the tube is reduced.

4. An oscillator comprising an electron beam tube having a cathode, an accelerating and focusing electrode, and a target electrode, a tuned circuit connected to the target electrode, a source of energy connected between the cathode and the tuned circuit, and a connection from the tuned circuit to the accelerating and focusing electrode to vary the accelerating electrode potential in opposite phase to variation of the target electrode potential whereby the effective amplification of the tube is reduced.

5. An oscillator comprising an electron beam tube having a cathode, an accelerating and focusing electrode and a target electrode, a circuit including an inductance, a connection from one end of the inductance to the target electrode, a connection from the other end of the inductance to the accelerating electrode to reduce the effective amplification of the tube, and a source of energy connected between the cathode and the inductance at a point intermediate the two ends of the inductance.

6. The method of controlling the amplification of an electron beam tube having a cathode, an accelerating and focusing electrode and a target, which includes the step of supplying the accelerator electrode and the target electrode with a predetermined potential, and altering the accelerating and focusing electrode potential in proportion to time in the opposite sense of variations

of potential of the target electrode to reduce the effective amplification of the tube.

5 7. An oscillator comprising an electron beam tube having a cathode, an accelerating and focusing electrode and a target electrode, a network connected between the target electrode and the cathode, and an impedance connection connected from the network to the accelerating electrode to vary the voltage of the accelerating electrode in opposite phase to the target electrode voltage variation whereby the effective amplification of the tube is reduced.

8. An oscillator comprising an electron beam tube having a cathode, an accelerating and focusing electrode and a target electrode, a network connected between the target electrode and the cathode, and impedance feedback means connected between the network and the accelerating electrode to control the beam by varying the voltage of the accelerating electrode in opposite phase to the target electrode voltage variation.

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