Jan. 20, 1942. D. H. BLACK 2,270,405

RELAXATION OSCILLATION GENERATOR

Filed Aug. 8, 1939

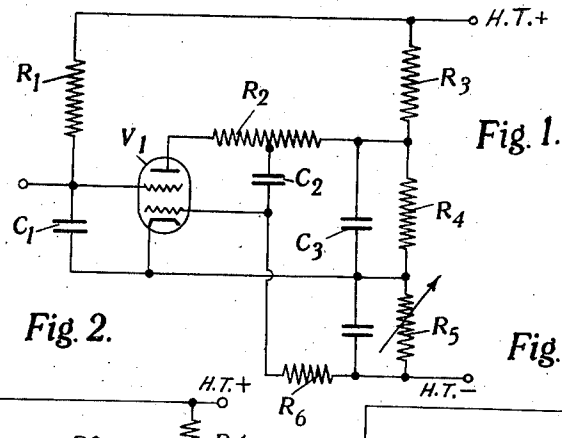


Fig. 1.

Fig. 2.

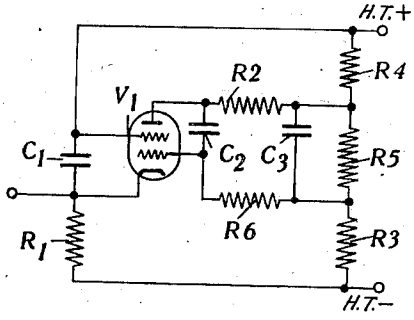


Fig. 3.

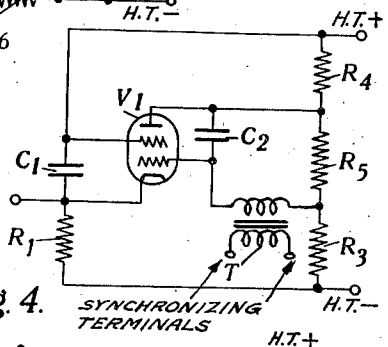


Fig. 4.

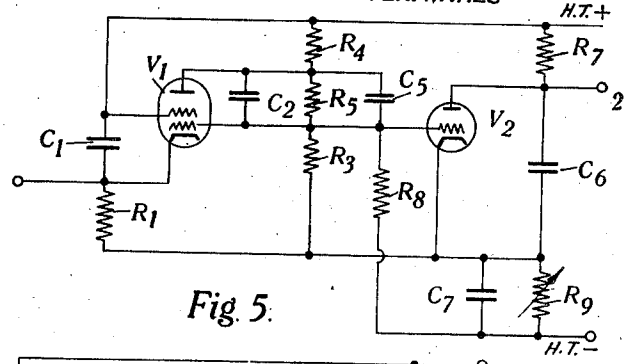
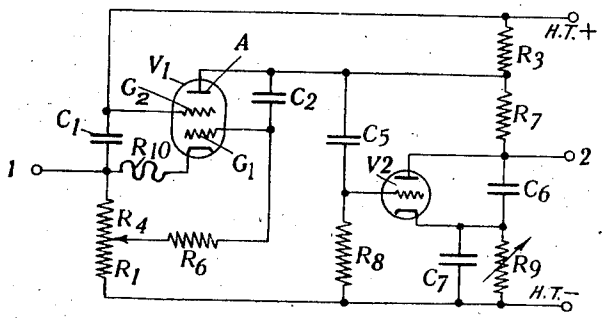


Fig. 5.



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Patented Jan. 20, 1942 2,270,405

UNITED STATES PATENT OFFICE

2,270,405

RELAXATION OSCILLATION GENERATOR

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Application August 8, 1939, Serial No. 288,935
In Great Britain August 19, 1938

4 Claims. (Cl. 250—36)

The present invention relates to relaxation oscillation generators and comprises improvements in the arrangements disclosed in my earlier U. S. Application No. 170,398, filed October 22, 1937, Patent No. 2,213,855, granted September 3, 1940.

The present application is a continuation in part of said earlier application.

In the parent application a relaxation oscillation generator is described comprising a condenser adapted to be discharged over the electron path in a single electron discharge device, the primary electron stream in which is controlled according to the strength of a secondary electron stream set up in the device. Thereby a rapid discharge of the condenser is obtained.

It is now proposed in such an arrangement to arrange the charging circuit in such a manner that the cathode potential in the electron discharge device grows more negative with respect to the mean potential of the other electrodes or with respect to the supply voltage as the condenser is being charged. Thereby a more complete discharge of the condenser and a more desirable wave form are obtained than with the circuits specifically described in the main patent.

It is also proposed to provide, in the arrangement of the main patent, a second condenser connected in a charging circuit having the same time constant as the first and adapted to be discharged by means of a further electron discharge device, the control electrode of which is subject to voltages derived from the secondary electron stream of the first electron discharge device. By such provision balanced deflection voltages for application to a pair of deflection plates in a cathode ray tube are obtainable in a simple and advantageous manner.

The invention will be further described with reference to the accompanying drawing in which:

Fig. 1 shows one form of circuit as specifically described in the main patent;

Fig. 2 illustrates modifications in accordance with the present invention;

Fig. 3 shows a simplified form of the circuit of Fig. 2;

Fig. 4 shows a circuit for providing balanced deflection voltages for a cathode ray tube; and

Fig. 5 shows a modification of the circuit of Fig. 4.

In Fig. 1 of the drawing the condenser C_1 is charged from a power source HT+, HT−, through a high resistance R_1. The anode of the tetrode valve V_1 has a convenient voltage, say 100 volts, applied to it from the said power source by means of the resistances R_3, R_4 and R_5. The first grid of V_1 is maintained at a negative value with respect to the cathode by means of the potential drop across R_5. As C_1 becomes charged the potential on the second grid of the valve rises until a point is reached at which electrons will commence to flow from the cathode to the second grid and the anode.

The surface of the anode of V_1 is of such a nature that it is capable of emitting secondary electrons, the number of secondaries exceeding the number of primary electrons. Therefore, as soon as primary electrons impinge on the anode secondary electrons will be emitted therefrom and will be collected by the second grid. This flow of secondary electrons from the anode causes a current to flow in the resistance R_2 which is of such a sign as to apply a positive impulse to the first grid of the valve by way of the condenser C_2. This positive impulse on the first grid allows more current to flow from the cathode and hence more secondary electrons flow from the anode, and the first grid becomes more positive. This process continues until the potential across the condenser C_1—and hence the potential between the second grid and the cathode, falls to such a value that the number of secondary electrons flowing from the anode to the second grid begins to decrease. When this stage is reached, the current through R_2 is decreased and the potential on the first grid of the valve begins to fall, the primary current thereby being reduced, resulting in a further reduction in the number of secondary electrons flowing, and the final return of the valve to its non-conducting state.

This type of oscillator has been operated with considerable success, and is noted for its extremely high rate of discharge, which is so desirable in many circumstances. It suffers, however, from one disadvantage. When secondary electrons flow from the anode to the second grid the anode tends to take up a potential very little different from that of the second grid. Consequently at the stage of the discharge when the number of secondary electrons begins to decrease the anode may be at a considerably higher potential than the potential derived from the current flowing in the resistances R_3, R_4 and R_5. This means that the condenser C_1 does not discharge sufficiently and instead of the voltage across C_1 falling to a voltage only slightly above that of the junction between R_3 and R_4, it may have a minimum value considerably higher than this. In extreme cases this minimum value may be as much as half the total potential applied

between HT+ and HT−, and—even in favourable cases—may be as much as one quarter of this value. The fact that the minimum potential to which C_1 falls is comparatively high has the effect of reducing the linearity of the oscillations, and is therefore undesirable.

This defect can be obviated by utilising the circuit shown in Fig. 2. In this circuit the second grid of tube V_1 is connected directly to the positive pole of a source of potential, while condenser C_1 is connected between the second grid and cathode, the latter being connected to the negative pole of the potential source through resistance R_1. A voltage divider composed of resistances R_3, R_5 and R_4 is connected across the terminals of the potential source. The anode is connected to the voltage divider through resistance R_2 at a point between resistances 4 and 5 while the first grid is connected through resistance R_6 to a junction point between resistances R_3 and R_5. The first grid is also connected by condenser C_2 to one terminal of R_2, while the opposite terminal of R_2 is connected by condenser C_3 to the junction point of resistances R_5 and R_3. In this circuit the second grid remains at a fixed potential and as the condenser C_1 becomes charged through the resistance R_1, the cathode becomes more and more negative. In the absence of any discharge through the valve, the anode is maintained at a lower potential than the second grid by means of the current flowing through R_4. Similarly, the first grid is maintained at a potential determined by the current flowing through R_4 and R_5. As the condenser C_1 becomes charged the cathode will eventually reach a potential at which current will commence to flow through the valve. Primary electrons reaching the anode will give off secondary electrons, thus causing a current to flow from the second grid to the anode and through the resistance R_2. As in the above-mentioned case, this flow of current through R_2 applies a positive impulse to the first grid through the condenser C_2 and the current through the valve increases. Owing to the fact that the second grid is in this case at a fixed potential the defect mentioned above in connection with the circuit shown in Fig. 1 cannot arise.

Fig. 3 shows a simplified version of Fig. 2 in which the resistances R_2 and R_6 and the condenser C_3 have been omitted. It has been found that the impedances of R_3, R_4 and R_5 may, in themselves, be sufficient to enable the necessary positive impulse to be applied to the first grid. In Fig. 3 the anode of tube V_1 is connected directly to the voltage divider between resistances R_4 and R_5, and the first grid is connected through the secondary of transformer T to the voltage divider between resistances R_3 and R_5.

The circuits shown in Figs. 2 and 3 are very convenient for use with cathode ray tubes, since the source of potential to operate the device may be the same as that used for the cathode ray tube itself.

It is frequently necessary when operating cathode ray tubes to apply a "balanced" sweep voltage to the deflecting plates. This is usually carried out by means of a phase inverting valve, but the operation of such devices is frequently far from perfect, mainly owing to the fact that the range of frequencies which has to be covered by the phase inverter is high.

In Fig. 4 is shown means for obtaining a balanced sweep circuit in a simple manner. That part of the circuit shown on the left of the diagram is the same as that shown in Fig. 3, described above. To the right of the diagram is shown another charge and discharge circuit. This circuit consists of a triode valve V_2 having its anode connected through resistance R_7 to the positive pole of the source of potential. The cathode is connected through condenser C_7 which bridges resistance R_9, to the negative pole of the source of potential, while the opposite terminal of resistance R_9 is connected through condenser C_6 to the anode circuit. The grid of V_2 is connected by condenser C_5 to the voltage divider between resistances R_4 and R_5 and is also directly connected to the junction point of resistances R_3 and R_5, as well as to the negative pole of the potential source through resistance R_8. The condenser C_6 is charged through the resistance R_7 and if the time constant of these is the same as the time constant of the R_1 and C_1 then the voltage across C_6 will rise at the same rate as the voltage across C_1. The anode of the triode valve V_2 is connected to the positive side of C_6 and bias for the grid of this valve may be obtained by means of the resistance R_9 shunted by the condenser C_7. The grid of V_2 is connected to the anode of V_1 by means of the condenser C_5. The bias applied to V_2 must be sufficient to prevent any current passing through the valve before the discharge in valve V_1 begins. When the discharge commences the rise in potential of the anode of valve V_1 is communicated to the first grid of V_1 and the grid of V_2, and this latter valve is thereby placed in a conducting state, and the condenser C_6 is discharged.

Synchronising of the oscillator with signals from some external source may be carried out in a number of ways. If the synchronising source is of sufficient magnitude and has sufficient impedance it may be connected directly across the first grid of V_1 and HT+, or preferably between the anode and HT. Alternatively, the signals may be injected into the first grid circuit by means of a transformer such as T in Fig. 3.

The principle of the invention is not limited to the circuits so far described, and one alternative circuit is shown in Fig. 5. In this circuit the resistance chain R_4, R_5, R_3 of Fig. 4 has been removed and the necessary potentials for G_1 and A of the valve V_1 are obtained from tappings on the two charging circuits. In Fig. 5, the second grid of tube V_1 is connected to the positive pole of the source of potential, and the first grid is connected through resistance R_6 to the junction point of resistances R_4 and R_1, the opposite terminal of the former being connected through resistance R_{10} to the cathode, resistance R_1 being connected to the negative pole of the potential source. Condenser C_1 is connected between the second grid and resistance R_4. Condenser C_2 is connected between the anode and the first grid. The anode is connected through resistance R_3 to the positive potential source.

The anode circuit of V_1 is connected through condenser C_5 to the grid of a triode V_2, whose plate is connected through resistances R_7 and R_3 to the positive terminal of the source of potential. The cathode of V_2 and also the grid are connected by resistance R_9, shunted by condenser C_7 to the negative pole of the source of potential. Condenser C_6 is connected across the anode and cathode of the triode V_2.

One of the features of this method of obtaining relaxation oscillations is the extreme rapidity of the discharge of the condenser C_1 (and C_6). In some cases it may be found that the rate of

discharge is too great, since the high frequency pulses generated during the discharges may react into other parts of the circuit. This rate of fly-back can be slowed down in a number of ways. One method is the insertion of a suitable resistance in the cathode circuit of V_1 such as R_{10} in Fig. 5. A similar resistance may be inserted in the cathode circuit of V_2 if desired. Alternatively resistances may be inserted in series with the second grid, G_2 of the valve V_1, and in the anode circuit of V_2. Other methods of achieving the same object will readily occur to those skilled in the art.

In the interests of brevity and precision the expressions "relatively charging" and "relatively discharging" are used hereinafter to denote opposite changes in the charge of a condenser without regard to whether the absolute potential difference across the condenser is greater in the relatively charged or the relatively discharged state. The expressions "absolutely charging" and "absolutely discharging" are used when it is intended to distinguish specifically between changes of charge which vary the total potential difference respectively away from and toward absolute zero.

What is claimed is:

1. A relaxation oscillation generator comprising a supply source having positive and negative terminals an electron discharge tube having a cathode, a control electrode, a secondary emissive electrode and a collecting electrode, a direct connection from said collecting electrode to said positive terminal and a connection, including an impedance, from said cathode to said negative terminal, a condenser connected between said collecting electrode and said impedance, means including said impedance for gradually relatively charging said condenser, bias means including said condenser for biasing said cathode with respect to said collecting electrode to a negative potential directly dependent upon the charge voltage of said condenser, said condenser being so connected that said bias of said cathode is most negative when said condenser is relatively charged, means including an impedance in series between said positive terminal and said secondary emissive electrode for biasing said secondary emissive electrode negatively with respect to said collecting electrode, means for biasing said control electrode negatively with respect to said collecting electrode, said biasing being of such value as to permit the passage of the electrons from said cathode to said secondary emissive electrode only when said condenser is relatively charged, an impedance in series between said secondary emissive electrode and said means for biasing said secondary emissive electrode to cause the latter to become more positive in response to the emission of secondary electrons therefrom, and means coupling said control grid to said secondary emissive electrode in such sense as to render said control grid more positive in response to an increased positive potential of said secondary emissive electron.

2. A relaxation oscillation generator comprising a supply source having positive and negative terminals, an electron discharge tube having a cathode, a control electrode, a secondary emissive electrode and a collecting electrode a direct connection from said collecting electrode to said positive terminal and a connection, including an impedance, from said cathode to said negative terminal, a condenser connected between said collecting electrode and said cathode, means for gradually relatively charging said condenser, bias means including said condenser for biasing said cathode with respect to said collecting electrode to a negative potential directly dependent upon the charge voltage of said condenser, said condenser being so connected that said bias of said cathode is most negative when said condenser is relatively charged, means including an impedance in series between said positive terminal and said secondary emissive electrode for biasing said secondary emissive electrode negatively with respect to said collecting electrode, means for biasing said control electrode negatively with respect to said collecting electrode, said biasing being of such value as to permit the passage of electrons from said cathode to said secondary emissive electrode only when said condenser is relatively charged, an impedance in series between said secondary emissive electrode and said means for biasing said secondary emissive electrode to cause the latter to become more positive in response to the emission of secondary electrons therefrom, condenser means coupling said control grid to said secondary emissive electrode, and an impedance in series between said control electrode and said cathode for rendering such coupling effective to alter the potential of said control electrode.

3. Relaxation oscillation generator comprising positive and negative supply terminals, a condenser and a charging impedance connected in series across said terminals with the impedance on the negative side of the condenser, an electron discharge device having a cathode, a control grid, a collecting electrode and a secondary emissive electrode, said cathode being connected to the negative side of the condenser and said collecting electrode being connected to the positive side of the condenser, a galvanically conductive connection from the negative supply terminal to said secondary emissive electrode for biasing said secondary emissive electrode negatively with respect to said collecting electrode, said connection including an impedance for causing the potential of said secondary emissive electrode to become more positive in response to the flow of secondary electrons therefrom, bias connections for normally biasing said control grid to a potential such as to permit the flow of electrons from said cathode to said secondary emissive electrode only in response to the acquisition of a substantial absolute charge upon said first mentioned condenser, and a coupling condenser connected between said secondary emissive electrode and said control grid.

4. A relaxation oscillator comprising a supply source having positive and negative terminals, a potentiometer connected across said terminals, an electron discharge tube having a secondary emissive electrode connected to a point of given potential on said potentiometer, a control grid connected to a point of lower potential on said potentiometer, a cathode connected to a point of still lower potential of said supply source, and a collecting electrode connected to said positive terminal, a condenser connected between said collecting electrode and said cathode and a condenser connected between said secondary emissive electrode and said control grid.

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