

Sept. 19, 1944.

A. V. BEDFORD

2,358,297

BLOCKING OSCILLATOR

Filed July 31, 1940

2 Sheets-Sheet 1

Fig. 1.

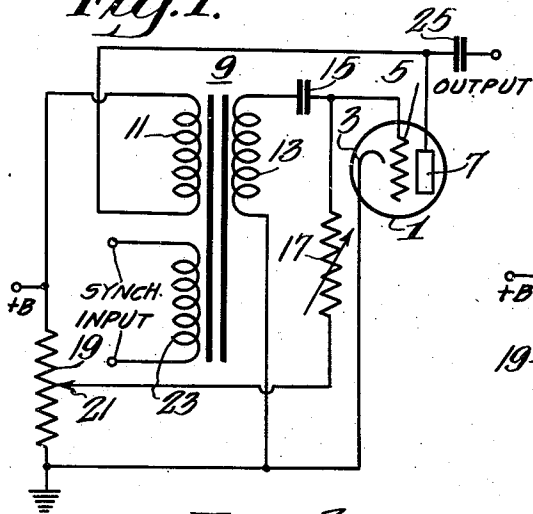


Fig. 2.

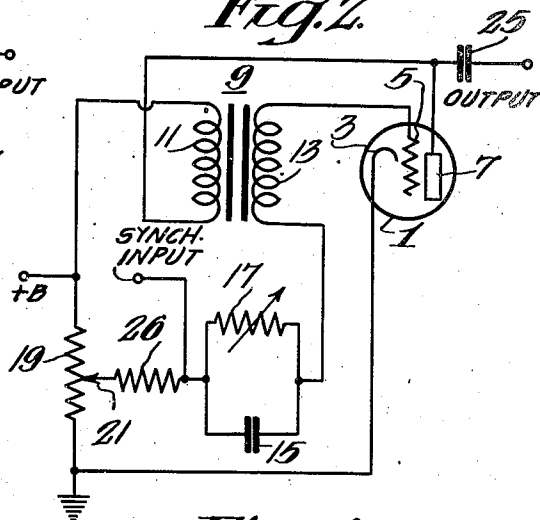


Fig. 3.

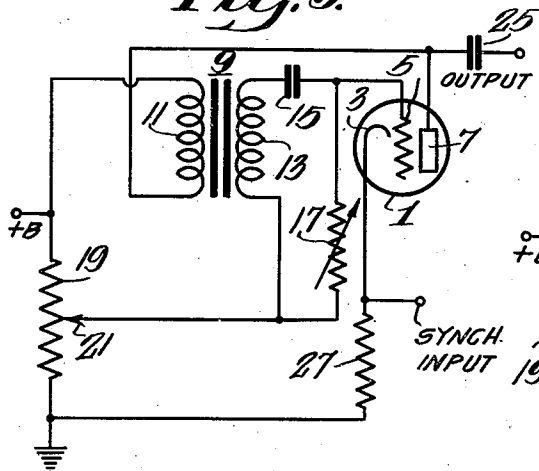


Fig. 4.

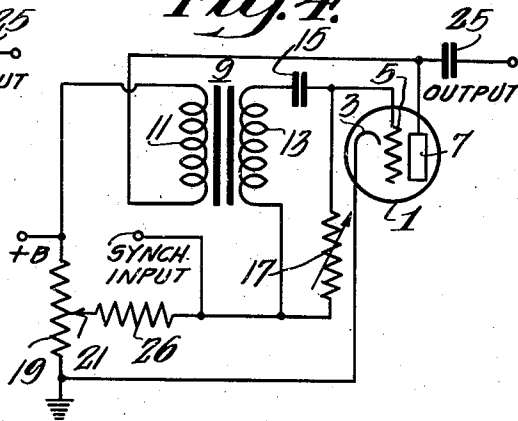


Fig. 5.

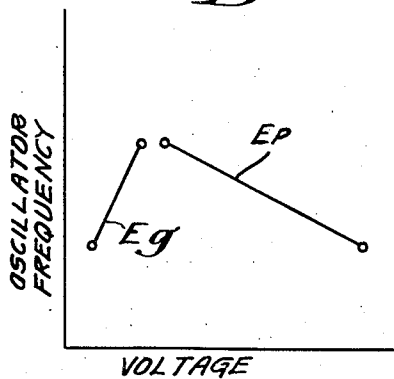
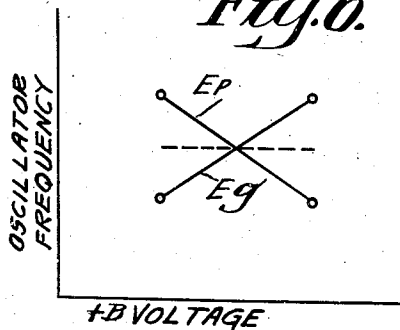


Fig. 6.



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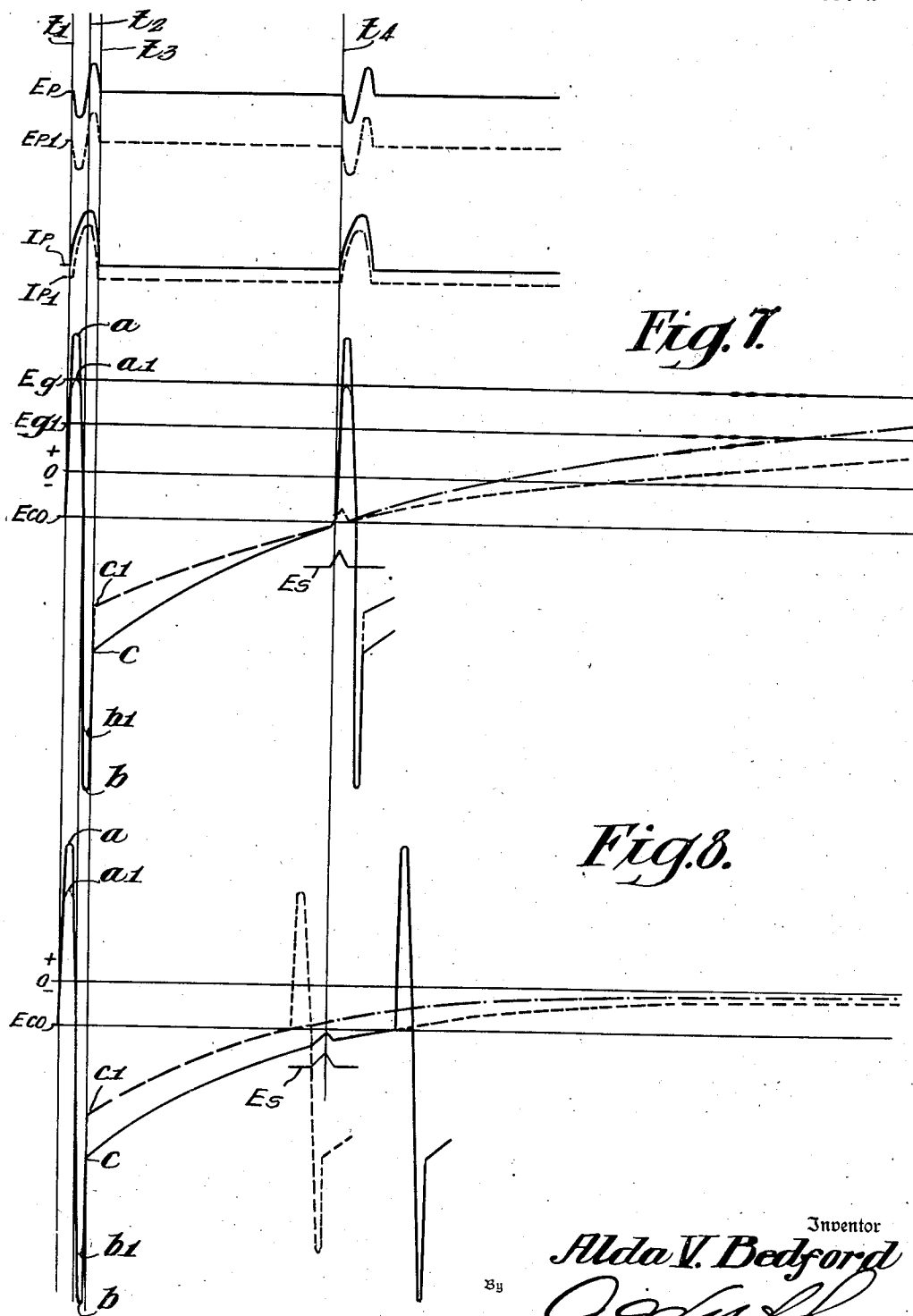


Fig. 7

Fig. 8

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UNITED STATES PATENT OFFICE

2,358,297

BLOCKING OSCILLATOR

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4 Claims. (Cl. 250—36)

This invention relates to improvements in television systems and, more particularly, to an oscillator for synchronizing the operating action at a receiving station with that at a transmitting station.

In television receiving systems using a cathode ray tube to produce optical images from the received signal energy, a deflection system for causing a saw-tooth current wave at a predetermined line scanning frequency is used to deflect the ray in one direction, for example, horizontally. There is also a second deflection system for causing a saw-tooth current wave at the desired framing frequency to deflect the ray in another direction, for example, vertically.

For the purpose of synchronization, an oscillator, such as the blocking oscillator shown in the Tolson, et al., Patent No. 2,101,520, granted December 7, 1937, generates sharply peaked output voltages which are utilized to drive the deflection systems in synchronism with the deflection systems at the transmitter.

While these systems have been found to lend themselves to satisfactory operation, a distinct operating disadvantage thereof resides in the fact that the frequency of oscillation of the oscillators previously used is controlled by the applied plate voltage. Relatively small variations in supply voltages, therefore, are effective to change the frequency sufficiently to throw the system out of synchronism.

There are many reasons why a more stable oscillator is desirable. For example, a more stable oscillator will remain in step with synchronizing pulses of lower amplitude, interference for a given location will have a constant amplitude relative to the amplitude of the synchronizing signal and therefore by the application of less signal to the deflecting circuits there is less interference signal applied. This results in a smaller difference in scanning line length which difference is due to the irregular amplitude of the synchronizing pulses when an interference signal is present. Any difference in scanning line length resulting from synchronizing pulses having irregular amplitudes causes a loss in detail of the optical image.

Another very important advantage gained by the use of a more stable synchronizing oscillator is that it is possible to dispense with the manual controls of the existing system for maintaining the oscillator in synchronism with the transmitted synchronizing pulses.

Since a sine wave is not desired, it is not

possible to use a tuned circuit oscillator without great complication, but it is necessary to provide a generator producing sharply peaked voltage pulses with good frequency stability.

There are substantially three things which govern the frequency of an oscillator; namely, the tube characteristics, the circuit constants, and the voltage supply. If the frequency of the discharge device and its associated circuit are not affected by temperature changes or other like disturbances, it remains that the only item affecting the frequency is the oscillator circuit voltage supply.

According to this invention, for the deflection of the cathode ray, a sharply peaked output voltage wave is generated by employing an improved oscillator circuit whose frequency response remains substantially constant during plate supply voltage variations. This is accomplished by biasing the control electrode with a positive potential derived from the anode supply voltage. A change in positive control electrode bias voltage has the opposite effect on the oscillator frequency, as does the change in the anode potential in the same direction. This results in a cancelling of change, so that the oscillation generator frequency remains substantially constant.

With the foregoing in mind, the primary object of this invention is to provide an improved oscillator circuit for generating sharply peaked output voltages which maintains its required frequency of oscillations independent of occurring variations in the supply voltages over a range usually met with in practice.

Other and incidental objects of the invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawings in which

Figures 1 to 4 are circuit diagrams showing different forms of this invention, and

Figures 5, 6, 7 and 8 are explanatory diagrams relating to the operation of this invention.

Referring to Fig. 1, the oscillation generator includes a discharge device such as a thermionic tube 1 having a cathode 3, a control electrode 5 and an anode 7. A transformer 9 provides inductive coupling between the anode 7 and control electrode 5. The primary 11 of the transformer 9 is connected in the anode potential supply circuit and secondary 13 is connected to the control electrode through a coupling condenser 15. The variable resistance 17 provides a leak-

age path for the electrical charge stored in the coupling condenser 15. A potentiometer 19 is inserted across the anode voltage supply source and its variable tap 21 is connected to and impresses a positive potential on the control electrode 5 of tube 1, which positive potential is directly proportional to the anode supply voltage. The synchronizing voltage from a television receiver, and for example one such as shown and described in U. S. Patent No. 2,137,039, is fed to the circuit through an auxiliary transformer winding 23. The output of the oscillator is taken from the anode circuit through the coupling condenser 25.

The operation of the oscillator circuit will now be explained with reference to Fig. 7. Time is represented along the abscissa and plate voltage represented by E ; and E_{pl} , plate current represented by I_p and I_{pl} , control electrode bias represented by E_g , E_{gl} and the control electrode potential required to cut off the anode current is represented by E_{co} . At the beginning of a cycle, for example, at time t_1 the control electrode 5 is at cut off voltage and the anode 7 starts to draw current through winding 11 of transformer 9 causing an induced voltage in transformer winding 13. The polarity of the transformer winding 13 with respect to winding 11 is such that the control electrode 5 is then driven more positive. An increase in positive bias on the control electrode 5 causes a still further increase in anode current. Due to the fact that the transformer 9 presents an inductive load to the anode current in its winding 11 the voltage impressed on the control electrode 5 tends to lead the anode current in winding 11 so that when the anode current approaches saturation the polarity of the potential induced in winding 13 reverses and causes the control electrode potential to return rapidly to its axis which has shifted in the negative direction due to the accumulated charge on the condenser 15 caused by control electrode rectification.

Anode current is limited at time t_2 because of the saturated condition of tube 1. The anode current limiting action of this tube condition is due to the fact that the negative charge of the electrons flowing from the cathode 3 to the anode 7 tends to repel any further electron emission from the cathode 3 so that when a large number of electrons are in the space between the cathode 3 and the anode 7, due to a heavy current flow, this negative charge is sufficient to prevent any further increase in anode current. It is also true that the electron emission of the cathode 3 is limited by its physical characteristics.

When the positive control electrode potential begins to drop, the anode current quickly decreases by reason of the fact that, at the moment the anode current begins to decrease at time t_2 , the potential of the control electrode is very rapidly made more negative by the action of the transformer windings 11 and 13. This sudden decrease in anode current through winding 11 drives the control electrode 5 to a negative potential b far below that necessary for cut-off.

The potential b is a transient potential due to the very rapid decrease in plate current at the start of the cycle and the control electrode potential therefore returns to a value c corresponding to the negative charge stored in the condenser 15. During this cycle of the control electrode voltage the negative charge stored by the condenser 15 is not appreciably affected by resistance 17 because the latter is relatively high

compared to the resistance between the control electrode 5 and the cathode 3 while control electrode is at a positive potential with respect to the cathode 3 and the time elapsing between t_1 and t_2 is relatively small with respect to the time taken for each complete cycle.

The range of voltage represented from c to E_{gl} is the voltage stored across the condenser 15 because of control electrode rectification during the time when the control electrode is positive and draws current. The negative charge stored in condenser 15 at time t_3 and represented by voltage c is beyond the cut-off point of tube 1 in a negative direction, so that no anode current flows from time t_3 to t_4 and this charge is allowed to leak off through resistance 17 as represented by the control electrode potential curve between t_3 and t_4 which takes the form of a logarithmic curve approaching E_{gl} asymptotically. The reason for the logarithmic decay of voltage, is that at point c the stored potential is large and therefore a heavier current flows, as the potential due to the stored charge in condenser 15 decreases the current decreases, hence the charge decreases less rapidly near the end of the curve.

It can be seen that the positive bias E_{gl} from the potentiometer tap 21 increases the rate of decay of the stored potential because the curve approaches this potential E_{gl} instead of the cathode or zero potential. However, the control electrode potential curve intercepts the bias potential value E_{co} , representing the cut-off voltage of the tube 1, before all the stored potential has been dissipated through resistance 17 and at this point anode current begins to flow again and the cycle is repeated.

The frequency of the recurrence of the pulses of the oscillator can therefore be adjusted by changing the value of resistance 17 in order to change the rate at which the negative charge leaks off condenser 15 to allow the tube 1 to again draw current.

The time t_1 to t_3 is determined primarily by the natural period of the windings 11 and 13 of the transformer 21 and their associated circuits and the anode draws current only during this time as shown by the curve marked I_p .

Since the load circuit of the anode is inductive, the setting up of a counter-E. M. F., due to the current in the inductance, results in a derivative type of voltage wave in the output circuit. Such a wave is represented by curve E_p .

In actual operation, the time t_1 to t_3 covers only a very small portion of the total time t_1 to t_4 representing a complete cycle of the oscillation generator. Time t_1 to t_3 has been extended in the graph to more clearly show the shape of the curve. As previously explained, this portion of the curve t_1 to t_3 depends for its shape and time on the characteristics of the coupling transformer, control electrode, and coupling condenser. This combination of elements has a resistance value which changes during the cycle thus causing a non-balanced wave whose axis shifts along the line E_{co} to c because of a potential across the condenser 15 resulting from the stored energy.

The time t_3 to t_4 represents that time required for the discharge of energy stored by condenser 15 during which time the potential of the control electrode approaches the cut-off value of the tube 1. Although the control electrode potential curve approaches a value of bias voltage represented by E_{gl} , it will be readily understood that long before the energy stored in condenser 15 is allowed to leak off completely, the control elec-

trode potential will reach its cut-off value and cause the flow of anode current and consequently the start of another cycle as represented at t_4 .

The resistance 17 is adjusted so that the charge stored in the condenser at t_3 leaks off at a rate such that the control electrode potential approaches closely to the cut-off point at time t_4 . At this time t_4 , a sharp synchronizing pulse E_s is impressed upon the control electrode circuit to raise the potential on the control electrode past the cut-off potential so that at time t_4 conditions will be such that the anode can again draw current to start the next succeeding operating cycle.

The time required for the discharge of condenser 15 is determined by the ratios existing between the value of resistance 17, the capacity of the condenser 15 and the positive control electrode potential applied by the potentiometer 19 through its variable tap 21. An increase in positive control electrode potential increases the rate of discharge of condenser 15.

In actual practice, the anode supply voltage $B+$ is likely to change in value, and if oscillators of the type shown in the prior art are used, any decrease in anode potential causes a corresponding increase in oscillator frequency because of a smaller amount of stored potential in condenser 15 and thus a shorter time interval between t_3 and t_4 as shown by the dashed line in Fig. 8. This can be further explained by the fact that under conditions of lower anode voltage such as E_{p1} the control electrode potential reaches a voltage a_1 rather than voltage a . The reason for this is evident in view of the fact that a decreased plate voltage E_{p1} is accompanied by a corresponding lower anode current I_{p1} , this in turn reduces the control electrode peak voltage to a_1 causing less control electrode rectification voltage to be stored across the condenser 15.

Referring to Fig. 7, it follows that the control electrode bias is reduced proportionally because this bias potential is derived from the anode voltage through the potentiometer 9 and its tap 21. This lower control electrode positive bias is represented in Fig. 7 as E_{gl} . Because of the lower control electrode rectification voltage stored in condenser 15 under this condition of lower anode potential, the control electrode potential returns to point c_1 at time t_3 . At this point the stored voltage begins to leak off through resistance 17. However, this time the logarithmic voltage curve approaches asymptotically the line representing the control electrode bias E_{gl} . So that by properly adjusting the circuit constants the two curves representing different $B+$ supply potentials may be made to intersect the cut-off value of the tube 1, represented by E_{co} , at substantially the same point.

In Fig. 5 is shown the effect of a change in anode potential E_p on the oscillator frequency. It will be noticed that between certain practical limits the oscillator frequency decreases at a substantially uniform rate during an increase in anode voltage E_p . It is also apparent from the curve E_g that the oscillator frequency will increase with an increase in positive control electrode bias voltage. The increase in oscillator frequency due to a change in control electrode bias is much more rapid for a given change of potential than is the case of the change due to a change of anode potential. Therefore, by causing the control electrode positive bias to increase in proportion to any increase in anode potential, a curve results which is represented in Fig. 6 in which the oscillator frequency remains sub-

stantially constant over a practical range of $B+$ supply voltage.

Fig. 8 shows the operation of such an oscillator as disclosed in Fig. 1 without the application of a positive bias to the control electrode. It will be noted that the control electrode potential returns to potential c and approaches asymptotically to a line represented by zero control electrode voltage. However, in the case of a lower anode potential E_{p1} the control electrode voltage returns to c_1 and returns asymptotically to the same reference of zero control electrode bias as does the logarithmic curve beginning at c_3 , a greater negative control electrode potential. It necessarily follows that each of these two curves will intersect the control electrode cut-off potential E_{co} at different points, resulting in a different oscillatory frequency under conditions of different supply potential. The $B+$ supply potential may be low enough to cause the control electrode potential to reach the cut-off voltage prior to the time of the synchronizing pulse E_s and cause a start of another cycle before t_4 . On the other hand, the anode supply voltage may be great enough to cause the control electrode bias to be such at time t_4 that the synchronizing pulse E_s won't raise it to the cut-off value and, consequently, the oscillator won't be triggered at time t_4 and the frequency will drop down.

Another form of this invention is shown in Fig. 2 in which the storage condenser 15 is placed in parallel with the leakage resistor 17 and this combination is placed in series with the transformer winding 13 which is, in turn, connected to the control electrode 5. The operation of this circuit is substantially the same as for the one shown in Fig. 1, and previously described. The fact that the bias potential from potentiometer tap 21 is not inserted across the storage condenser does not in any way alter the rate of discharge of control electrode rectified voltage through resistance 17. In the case of Fig. 2, the synchronizing input voltage is impressed across a resistance 25 connected in series with the control electrode circuit so that there appears a synchronizing potential across the resistance 26 causing a triggering of the tube in a manner similar to that described for Fig. 1.

There is, however, a definite advantage gained by the use of this series circuit and the insertion of the synchronizing pulses directly in the control electrode circuit rather than in transformer 9. It has been discovered that the time constant of the transformer windings 11 and 13 and its associated circuit causes a slight change in the shape of the synchronizing pulses.

If we examine the control electrode circuit in Fig. 1, we find that condenser 15 feeds the synchronizing pulses to resistance 17, which has a relatively low impedance as compared to the control electrode. Therefore, the low frequencies are attenuated because of the increased impedance of the condenser 15 at low frequencies. In Fig. 2, however, the parallel combination of resistance 17 and condenser 15 are effectively in series with the relatively high impedance of the control electrode 5 so that no appreciable attenuation of low frequencies results.

As previously explained, the difference in fixed potential across the storage condenser 15 due to that which is applied through potentiometer tap 21 does not affect the rate of change of voltage across the condenser 15 because the potential derived from the anode supply source is a static potential to which any further charge on

the condenser tends to approach.

Fig. 3 shows another modification of this invention in which the synchronizing impulses are inserted in the cathode circuit across resistor 27. It will also be noticed that the winding 13 of the transformer 9 is returned to the potentiometer tap 21 rather than to ground, as shown in Fig. 1.

Fig. 4 shows still another modification of the invention. The synchronizing voltage is impressed in series with the control electrode circuit across resistor 25 while the transformer winding 13 is returned to a position between resistances 17 and 25.

It will be noticed that the synchronizing pulses may be fed to the oscillation generator at a number of different positions because it is only necessary to disturb the control electrode potential by an amount sufficient to cause it to pass the cut-off value of the tube and thus to start another cycle. The point at which the synchronizing pulses are to be fed can then be determined by the synch. separating circuit which may be such that it will feed into one value of impedance better than another.

While a number of systems for carrying this invention into effect have been indicated and described, it will be apparent to one skilled in the art that this invention is by no means limited to the particular organization shown and described but that many modifications may be made without departing from the scope of this invention as set forth in the appended claims.

I claim as my invention:

1. In an oscillation generator, the combination of an electron discharge device provided with a cathode, an anode and a control electrode, a circuit connected between said anode and cathode, means for coupling said circuit to said control electrode to cause said control electrode to go more positive in response to an increase in anode current and more negative in response to a decrease in anode current, said coupling means including a condenser to receive a charge during a relatively small part of each complete operating cycle for applying to the control electrode a potential more negative than that required for cut-off, a voltage source, means for applying from said source a voltage between said anode and said cathode, a potential divider connected across said voltage source and having an intermediate tap connected to said control electrode through a resistive element, said tap being located at a point on said divider where the voltage is such that the variations in bias on the control electrode resulting from any variations in the voltage from said voltage source cause the frequency of oscillation of said generator to remain substantially constant.

2. In an oscillation generator, the combination of an electron discharge device provided with a cathode, an anode and a control electrode, a

condenser to receive a charge during a relatively small part of each complete operating cycle for applying to the control electrode a potential more negative than that required for cut-off, a transformer having a winding in a series circuit including said anode, cathode and a potential divider, said transformer having another winding in a second series circuit including said control electrode, cathode, condenser, and a portion of said potential divider.

3. In an oscillation generator, the combination of an electron discharge device provided with a cathode, an anode and a control electrode, a series circuit connected between said anode and cathode and including a source of anode potential, a potential divider across said source, a series circuit connected between said control electrode and said cathode and including a condenser to receive a charge during a relatively small part of each complete operating cycle for applying to said control electrode a potential more negative than that required for cut-off, a resistive element, and a portion of said potential divider and means for coupling said circuits together in such a manner to cause said control electrode to go more positive with respect to said cathode in response to an increase in anode current and more negative in response to a decrease in anode current.

4. An oscillator for producing electrical impulses periodically, said oscillator comprising an electron discharge tube having a control grid and having a plate circuit and a grid circuit, said circuits being inductively coupled by means of a transformer having a primary winding in said plate circuit and a secondary winding in said grid circuit, said coupling being in such direction that said control electrode is made more positive in response to an increase in plate current, a grid condenser connected in series with said secondary winding whereby said condenser receives a charge of the proper polarity and of sufficient magnitude to block said tube, and a grid resistor for causing said charge to leak off, the values of said grid condenser and said grid resistor being so high and the damping of said plate and grid circuits being so great that each cycle of operation of the oscillator includes a damped sine wave followed by a period of rest, said damping being so great that said grid is driven positively only once during the occurrence of said damped wave, a direct-current voltage source in said plate circuit for supplying a positive operating potential to the plate of said tube, said voltage source being subject to undesirable voltage variations, and means for applying to said control grid through said grid resistor a positive bias voltage which varies in proportion to said undesirable voltage variations and which has a value such that said undesirable voltage variations have substantially no effect upon the periodic rate of the impulses produced by said oscillator.

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