

Nov. 8, 1938.

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2,135,740

SERRATED WAVE FORM GENERATOR

Filed Dec. 20, 1935

Fig. 1

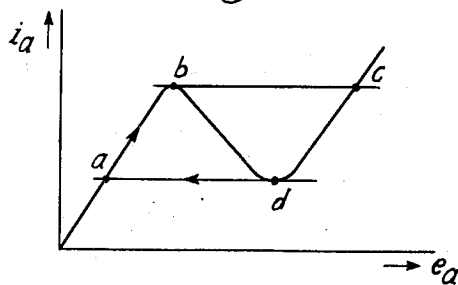


Fig. 2

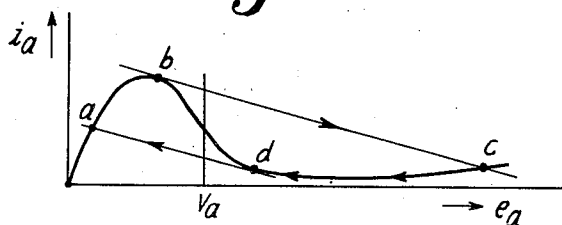
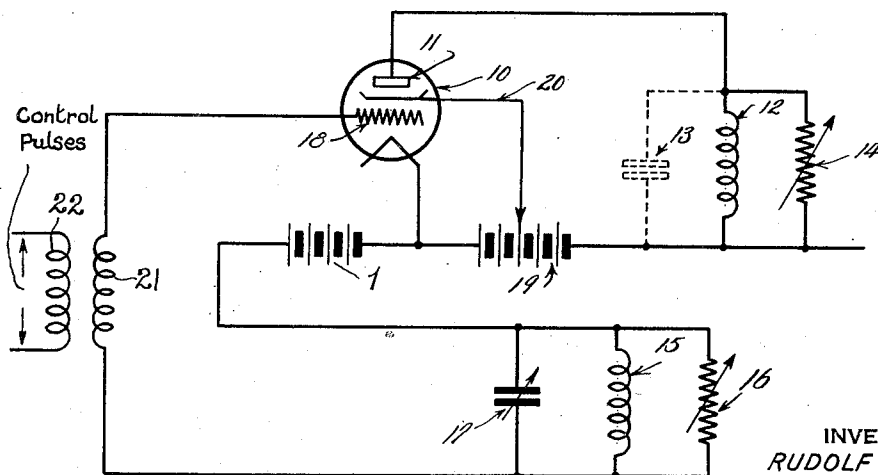


Fig. 3



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2,135,740

SERRATED WAVE FORM GENERATOR

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Application December 20, 1935, Serial No. 55,494
In Germany December 20, 1934

7 Claims. (Cl. 250—36)

My invention relates broadly to apparatus for producing a "saw-toothed" or serrated wave form and relates more particularly to such devices wherein the similarity between a multi-grid tube characteristic and a dynatron characteristic is availed of to produce a more desirable wave. This wave is of special value for use with deflecting apparatus of cathode ray tubes.

As it is well known in the art, series connections consisting of inductances and devices with dropping current-voltage characteristics of the dynatron type produce oscillations among whose characteristics are sudden rises of potential, angular shaped current waves which are analogous to the parallel connection of capacities and devices with falling current-voltage characteristics of the arc type whose characteristics are sudden rises of current, angular shaped voltage waves.

Furthermore, it is known, that a tube in which the control grid voltage varies in dependency with variations on the plate potential of the tube, which may be accomplished by means of certain circuit connections in phase opposition to the plate potential, commonly called voltage feed back, is equal to a device of dynatron type.

The difficulty of producing a saw-tooth current wave, which satisfies technical requirements regarding linearity, return stroke duration and frequency (particularly for television, frequencies of the order of 5000 cycles and a return stroke duration of 10% of the forward stroke duration) is caused by the fact, that the pure dynatron-characteristic (see Fig. 1) exhibits two positive branches of approximately equal slope, so that the forward stroke ($a-b$) and the return stroke ($b-d$) are passed in equal times. Shunting a resistance across a dynatron device or, what is the same, parallel damping the inductance, varies the amount of voltage rise, but it does not vary the proportion of the duration of the forward stroke to the duration of the return stroke (where forward and return refer to deflection of a cathode ray beam).

A characteristic, which is produced by means of voltage feed back (see Fig. 2), possesses one positive branch only, so that shunting a resistance (attenuation device) across it causes the forward stroke ($a-b$) to be passed slowly and the return stroke ($b-d$) to be passed quickly. In the diagram of Fig. 2 the resistance is supposed to be in parallel to the inductance, so that the lines representing the voltage rise are tilted.

The velocity of the rise of current ($a-b$) is determined by the time constant L/R (wherein

$$R = \frac{de}{di}$$

in the characteristic of the tube and the applied plate voltage V_a and L the inductance in the anode circuit). A slow rise of current, therefore,

requires either a large value of L or small value of V_a . The former is obtainable with certain reservations only, as the return stroke duration is at best equal to the resonance period of the circuit formed by the plate inductance and its distributed capacity (see Fig. 3). Applying low plate voltages is also possible to a limited extent only, as

$$\frac{di}{dt}$$

depends upon the distance measured in volts between the working point on the characteristic and the ordinate corresponding with the plate voltage V_a . Referring to Figs. 1 and 2, this means for small plate voltages a considerable change of

$$\frac{di}{dt}$$

when the slope ($a-b$) is passed through, and a rise of the current, which is not time proportional. In order to combine linearity, low frequency and rapid return stroke the only possibility remains to utilize a tube characteristic with extremely steep current rise within low plate voltage range and this property is possessed by the pure dynatron.

According to the present invention a so-called multi-grid tube is used as a back coupled tube, or the equivalent of a dynatron arrangement.

The use of a feed back circuit means exemption from the rather great tolerances encountered when secondary emission effects are present. The characteristic curves of multi-grid tubes may exhibit rises of current within a low plate voltage range, which correspond to a resistance of 400 Ω . and less, if the tube is suitably constructed; but even disadvantageously constructed multi-grid tubes, of which the pentode is one, offer values of about 800 Ω .

In order to utilize the natural period of resonance of the plate inductance for the return stroke, the feed back is so chosen, that the tube is fully blocked for a time corresponding to at least half the resonance period. For this purpose it is useful, to make the resonance period of the grid circuit (for instance by means of adding an additional capacity) at least equal to that of the plate circuit and, further, so to determine the attenuation of the plate circuit that an aperiodic condition is not attained.

In order to further reduce the duration of the return period, some measures, which are well known per se, are employed as non-capacitive winding, subdivided coils and so on. As the slope of the current rise is caused by the passage of the screen-grid current to the plate, steep rises are attained, when screen-grid current itself is large. Therefore it has proved useful to apply to the tubes such potentials that the direct cur-

rent flowing to the screen grid is, during the generation of oscillations, at least equal to, but as far as possible greater than, the plate direct current.

5 The arrangement as described above allows a simple adjustment of the frequency of oscillation by means of varying the plate voltage within the limits determined by the tolerance of the tube. In the same way it is feasible to synchronize these
10 oscillations with a transmitter for instance, by applying a synchronizing voltage in series with the back coupled voltage to the control grid. The use of relatively small values of inductance effects allows a considerable simplification in comparison with known arrangements, for instance
15 by utilizing as a plate inductance the deflecting coil of a cathode ray oscillograph or a television tube.

My invention will best be understood by reference to the drawing in which:—

Figure 1 is a curve illustrating the wave form of oscillations produced by negative resistance devices.

Figure 2 is a curve illustrating the oscillations
25 produced by multi-grid devices using re-generation; and

Figure 3 is one embodiment of my invention.

Referring to the figures, Fig. 1 illustrates an oscillation produced by a device of the negative
30 resistance type or, as is commonly called a dynatron. For a complete explanation of derivation of this curve, which is well known in the prior art devices, reference may be had to the article by E. W. Herold, appearing in the October, 1935,
35 issue of the Journal of the Institute of Radio Engineers (U. S.) beginning page 1201.

Referring to Fig. 2, as has been stated previously in the specification, an oscillation produced by a multi-grid tube using re-generation possesses
40 one positive branch only, so that the use of an attenuation device across the plate inductance effects a slow build-up of that part of the curve used ordinarily to deflect the cathode ray beam in its forward stroke and a rapid return stroke.

Referring to Fig. 3, a multi-grid vacuum tube
45 10, which, for instance, may be a screen grid, or a pentode, has its anode 11 joined in series with an inductance 12 which may, for instance be the magnetic deflecting coils of a cathode ray tube. The inductance 12 has an inherent distributed
50 capacity 13 which is shown in a dotted manner. Joined in parallel to inductance 12 is an attenuating member 14 which is variable. Coupled to the inductance 12 for regenerative purposes or, has been termed, feed-back purposes, is an inductive
55 member 15 joined in series with the grid 18 of the vacuum tube 10. A variable capacity member 17 is joined in parallel with the inductance 15, as is a variable attenuating means 16. Thus, the resonant period of the grid circuit may be made to equal, or vary from, the resonant period of the plate circuit. The screen grid 20 is joined to a positive voltage supplied by the source 19 and
60 has an adjustable means for varying the voltage applied to this grid. As previously stated, the voltage on the screen grid 20 should be so adjusted that the screen grid current normally exceeds the normal anode current when the tube is
65 oscillating.

Figure 3 further shows an arrangement of my invention wherein means for applying a synchronizing voltage to control the time of oscillation of the oscillator is connected in the control grid circuit of the tube. These means comprise a well-

known transformer coupling between, for instance, a television receiver, if this oscillator is used therein, and in which the synchronizing pulses have been separated from the video signals.

The multi-grid vacuum tube 10 has connected
5 to its plate 11 an inductive element 12 and joined in parallel with the inductive element is its distributed capacity illustrated as 13 and the variable attenuating means 14. This parallel circuit is then joined through potential source 19 to
10 the cathode of the tube, the potential source also serving to bias the screen grid 20 of the tube positively. Connected between the control grid 18 of the tube and the cathode thereof is an inductive element 15 which is coupled to the aforementioned inductance 12. Connected in parallel with
15 the inductance 15 is a variable attenuating means 16 and a variable capacity 17. Connected in series with the grid 18 is the secondary winding 21 of an input transformer, the primary 22 of which may be supplied with pulses from such as, for instance, a television receiver, although, of course, not specifically limited to such receiving means.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the
25 United States, is the following:

1. An oscillator for producing a serrated wave form comprising a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and
30 an anode, inductive means connected in an anode-cathode circuit of said tube, variable attenuating means joined in parallel to said inductance, means for biasing one of said grids of the tube positively with respect to the cathode thereof, a second inductive means connected between another of the grids of said tube and the cathode thereof and coupled to the aforementioned inductive means in the anode circuit of the tube, and variable
35 attenuating means joined in parallel to the grid circuit inductive means.

2. In an oscillator for producing a serrated wave form, a multi-grid vacuum tube, containing cathode, a plurality of grid electrodes and an anode, an inductance connected in series with the anode
40 of said tube and the cathode thereof, variable attenuating means joined in parallel to said inductance, an inductance connected in series with a grid and the cathode of said tube and coupled to the inductance in the plate circuit, means for controlling the coupling between said inductances so as to render the tube impervious
45 to current flow for a half cycle of oscillation of current in the inductance in the plate circuit of the tube, and means for biasing a screen grid of the tube with respect to the cathode.

3. An oscillator for producing a serrated wave form comprising a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and an anode, an inductance connected in an anode-cathode circuit of said tube, variable attenuating
50 means joined in parallel to said inductance, a second inductance connected between another of said grids of said tube and the cathode thereof, and coupled to the inductance in the plate circuit, means for controlling the coupling between said inductances so as to render the tube impervious
55 to current flow for a half cycle of oscillation of current in the inductance in the plate circuit of the tube, and means for biasing a screen grid of the tube with respect to the cathode to a value whereat the current flow in said grid exceeds the anode current during oscillation.

4. In an oscillator for producing a serrated wave form, a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and an
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anode, an inductance connected in series with the anode and cathode of the tube, a variable attenuating means joined in parallel to said inductance, a parallel resonant circuit joined in series to a control grid and cathode of the tube and variably coupled to the inductance in the plate circuit of the tube, variable attenuating means joined in parallel to the aforementioned resonant circuit, and means for positively biasing a screen grid of the tube with respect to the cathode.

5. An oscillator for producing a serrated wave form comprising a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and an anode, an inductance connected in an anode-cathode circuit of the tube, a variable attenuating means joined in parallel to said inductance, a parallel resonant circuit connected between a control grid of the tube and the cathode thereof and variably coupled to the inductance in the plate circuit of the tube, variable attenuating means joined in parallel to the aforementioned resonant circuit, and means for positively biasing a screen grid of the tube with respect to the cathode to a value whereat the current flow in said screen grid exceeds the anode current during oscillation.

6. An oscillator for producing a serrated wave form comprising a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and an anode, an inductance connected between

the anode and cathode of the tube and forming a resonant circuit, said resonant circuit having a frequency equal to the natural period of the inductance and its distributed capacity connected to the anode of the tube, a variable attenuating means joined in parallel to said inductance, a parallel resonant circuit connected between the control grid of the tube and the cathode thereof and variably coupled to the inductance in the plate circuit of the tube, variable attenuating means joined in parallel to the aforementioned resonant circuits, and means for positively biasing a screen grid of the tube with respect to the cathode.

7. An oscillator for producing a serrated wave form comprising a multi-grid vacuum tube containing cathode, a plurality of grid electrodes and an anode, inductive means connected in an anode-cathode circuit of said tube, variable attenuating means joined in parallel to said inductance, means for biasing a screen grid of the tube positively with respect to the cathode thereof, a second inductive means coupled to the aforementioned inductive means in the anode circuit of the tube and connected between a control grid thereof and the cathode thereof, variable attenuating means joined in parallel to the grid circuit inductive means, and means applying control voltage to a control grid of said tube for controlling the oscillation thereof.

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