Feb. 20, 1945. P. NAGY ET AL 2,369,749
METHOD OF AND MEANS FOR THE PRODUCTION OF ELECTRIC
POTENTIAL VARIATIONS OF TRIANGULAR FORM
Filed July 24, 1941 4 Sheets-Sheet 1

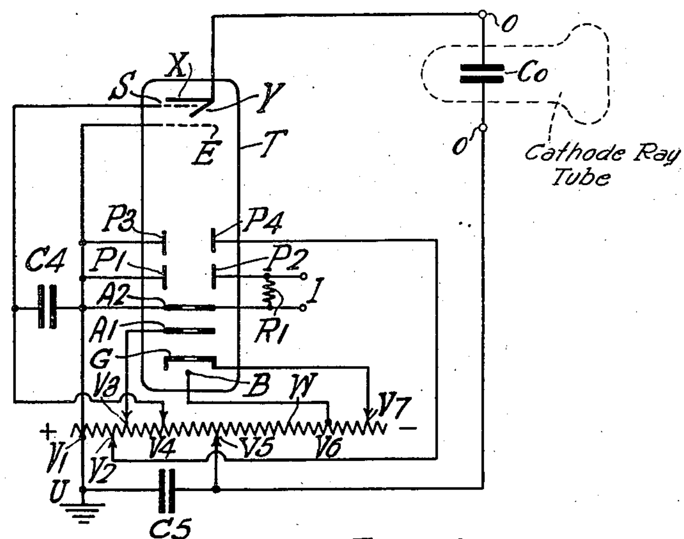

FIG. 1.

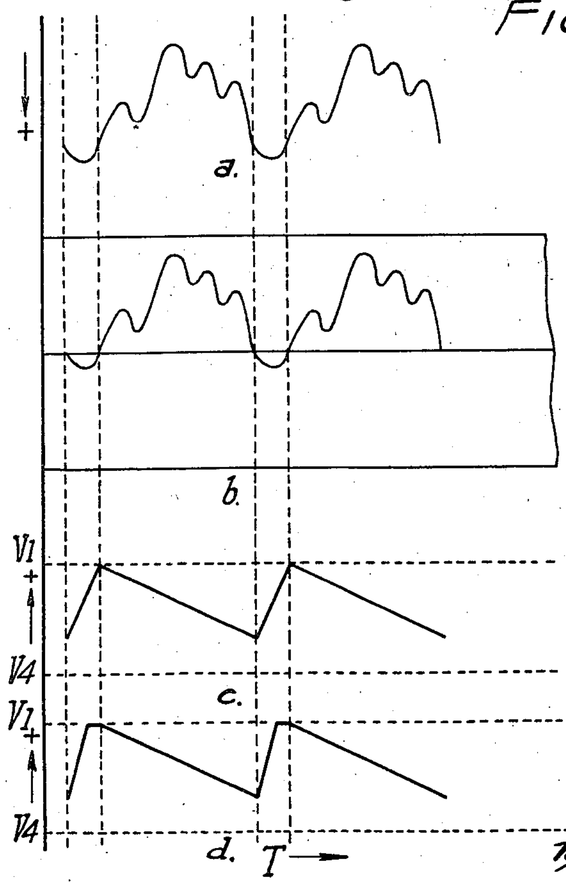

FIG. 2.

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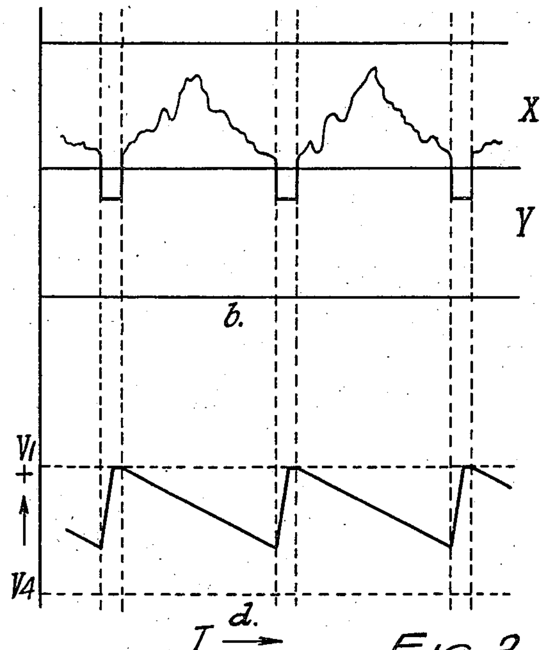

FIG. 3.

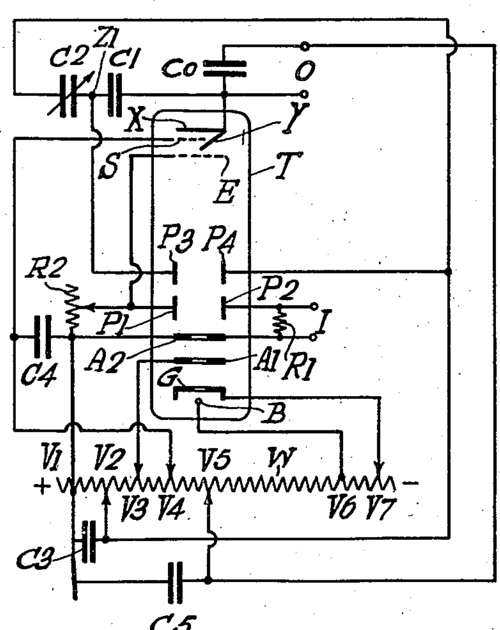

FIG. 4.

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METHOD OF AND MEANS FOR THE PRODUCTION OF ELECTRIC POTENTIAL VARIATIONS OF TRIANGULAR FORM

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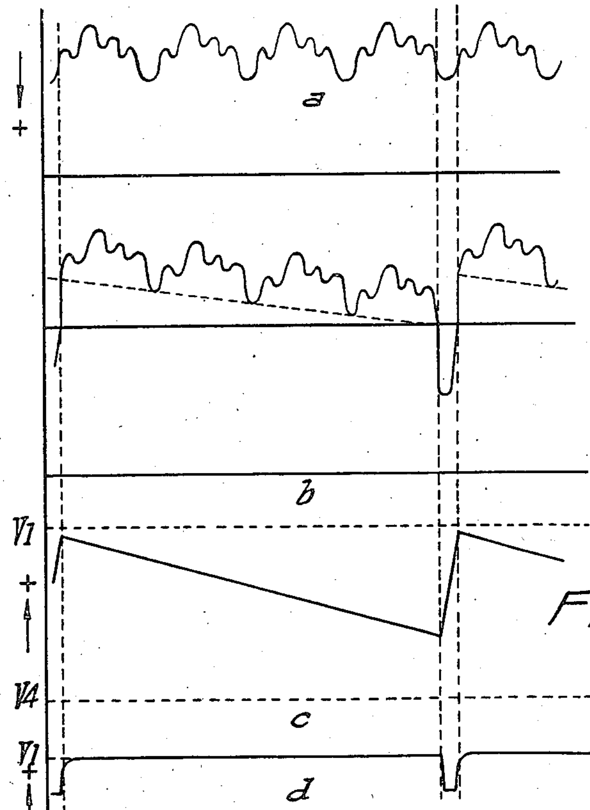

FIG. 5.

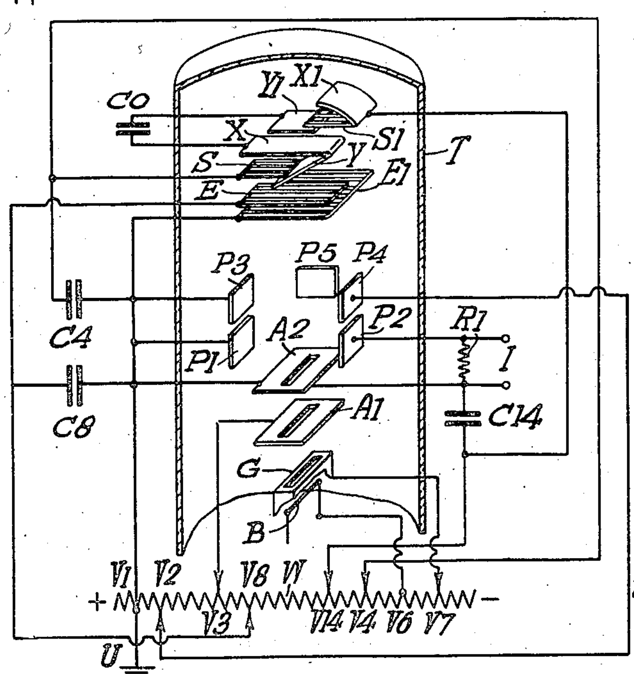

FIG. 6.

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METHOD OF AND MEANS FOR THE PRODUCTION OF ELECTRIC POTENTIAL VARIATIONS OF TRIANGULAR FORM

Filed July 24, 1941 4 Sheets-Sheet 4

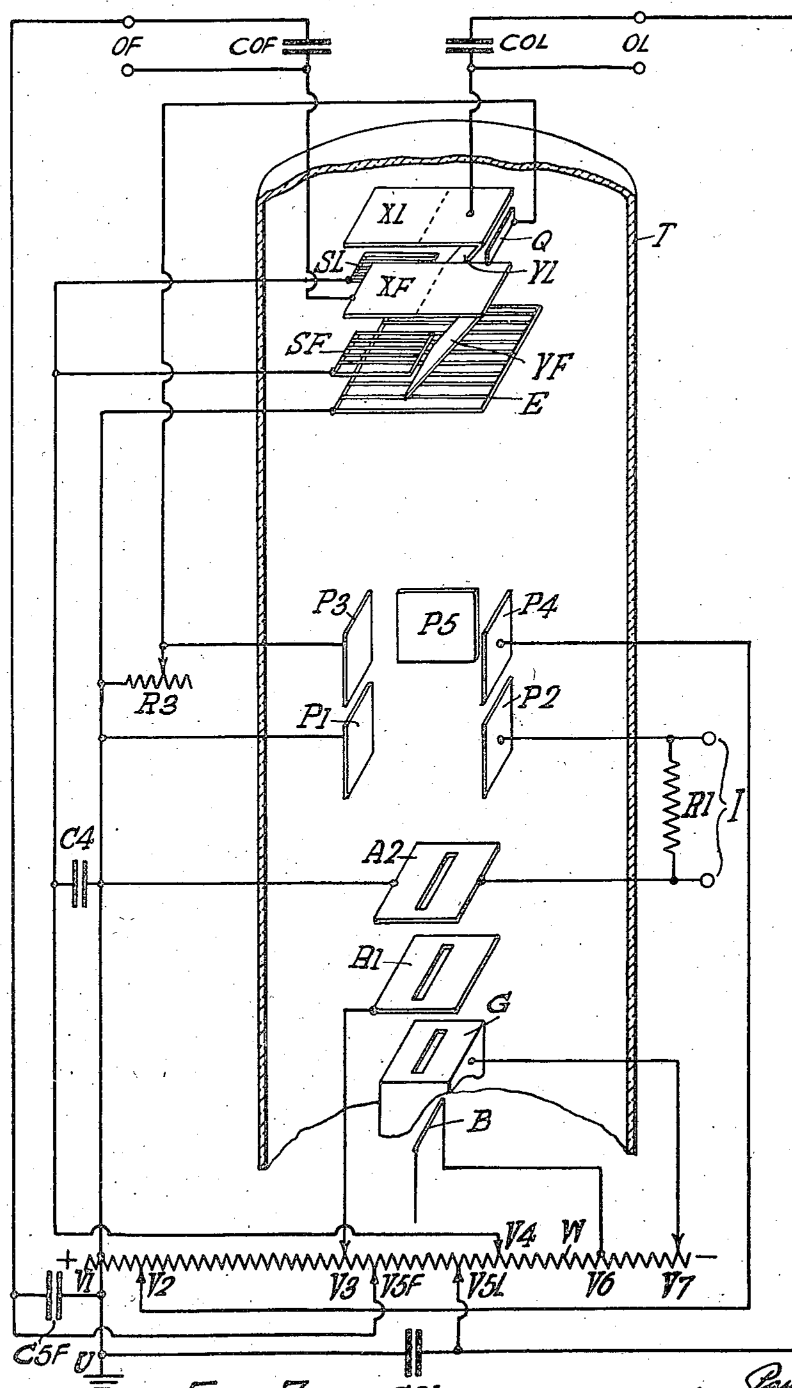

FIG. 7.

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UNITED STATES PATENT OFFICE

2,369,749

METHOD OF AND MEANS FOR THE PRODUCTION OF ELECTRIC POTENTIAL VARIATIONS OF TRIANGULAR FORM

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Application July 24, 1941, Serial No. 403,915
In Great Britain June 13, 1941

21 Claims. (Cl. 178—7.5)

This invention is concerned with the production of electric potential variations of substantially triangular form, such for example as saw-tooth potentials for deflecting an electron beam of a cathode ray tube employed in a television system or oscillograph apparatus.

At the present state of the art the production of such potential variations requires a comparatively complicated electrical equipment and at very high frequencies the production of such potential variations is extremely difficult, more especially if, as is usually the case, potential variations are required to be synchronised with given electric signals, in which latter case it is necessary to provide a locking or synchronising circuit.

The present invention is broadly distinguished from anything hitherto proposed by reason of the fact that the required electric potential variations of triangular form can be produced by the pure conversion of periodic signal components established at different amplitude levels, such for example as synchronising impulses and video signal components of a composite television signal or two periodic signal components of an electric wave it is desired to study by means of a cathode ray oscillograph.

Thus in operating a cathode ray tube device under the control of an electric signal having two periodic signal components established at different amplitude levels, one of which pertains to the frequency at which the electron beam of said cathode ray tube device is to be deflected, the invention consists in the method of generating beam deflecting potentials of triangular form which involves utilising one of said signal components to control the charging of a condenser means and utilising the other signal component to discharge said condenser means.

In the case of the reception of television signals which comprise synchronising components and video components, the method according to the invention of generating potential variations of saw-tooth form for controlling the deflection of a cathode ray beam of a picture re-constituting means, consists in utilising one of said signal components to control the charging of a condenser means and utilising the other signal component to discharge said condenser means.

According to another feature of the invention there is provided in or for a wave generating system adapted to produce electric potential variations of triangular form, an electron tube means comprising electrode means subject to the action of an electron beam, electrode means for controlling said electron beam in response to the application thereto of an electric signal having two periodic signal components established at different amplitude levels, said first mentioned electrode means being of such a character that one signal component of the composite signal applied to the control electrode means serves to bring about the electrical charging of a condenser means which is coupled to said first mentioned electrode means, and the other signal component serves to bring about the discharge of said condenser means.

According to a further feature of the invention there is provided in or for a wave generating system adapted to produce electric potential variations of saw-tooth form suitable for effecting the deflection of a cathode ray beam of a cathode ray tube device, adapted to respond to the effect of electric signals having two periodic signal components established at different amplitude levels and of different time duration, an electron tube means to which said composite signal is adapted to be applied and whereby one of said signal components serves to bring about the charging of a condenser means and the other signal component serves to bring about the discharging of said condenser means, said electron tube means functioning to discriminate between said signal components in such manner that the rate of charging and the rate of discharging are dissimilar in order to develop potentials of saw-tooth form across said condenser means.

Basically a means according to the present invention for generating electric waves of triangular form in response to electric signals having two periodic signal components established at different amplitude levels, comprises an electron tube means which includes control electrode means to which the composite signal is adapted to be applied, electrode means adapted to be electrically charged by an electron beam under the control of said control electrode means, so that one signal component serves to bring about the electrical charging of the said chargeable electrode means and the other signal component serves to bring about the discharging of said electrode means.

Further features of the invention will appear during the course of the following description with reference to the accompanying drawings, wherein the various figures show diagrammatically electron tube devices and associated circuits and various diagrams indicating the operation of such devices and circuits.

The function of charging and discharging the condenser means may in some cases involve charging an electrode positively (or negatively) in response to one of the two periodic signal components and negatively (or positively) in response to the other signal component.

In one preferred embodiment of the invention the electron tube employed is so constructed that an electron beam is controlled by the application of the composite signal so that, during one part of each cycle or period of the signal potential variation it impinges on, and thereby charges, one electrode, and during the remainder of each cycle or period it impinges on, and thereby charges, another electrode. The charging of the one electrode is utilised to produce the increasing portion of the required saw-tooth potential variation and the charging of the other electrode is utilised to produce the decreasing portion of this saw-tooth variation. The saw-tooth variation thus obtained is automatically synchronised with the electric signals applied to the tube, and saw-tooth variations of extremely high frequency (e. g., up to 5 megacycles) can be obtained.

The electrodes upon which the electron beam impinges may be each charged positively or each charged negatively by the action of the electron beam. In this case one electrode is connected to one plate of a condenser and the other electrode is connected to the other plate of the same condenser in the output circuit of the electron tube. The charging of one electrode then charges the condenser in one direction, while the charging of the other electrode charges the condenser in the opposite direction. The alternate charging of the two electrodes then charges the condenser alternately in opposite directions, and, provided that the rate of charging of the two electrodes is correctly chosen, and that a suitable circuit is provided to discharge the condenser, a saw-tooth potential variation is obtained across the condenser.

According to a preferred arrangement, however, one of the electrodes upon which the electron beam impinges is charged negatively by the action of the beam, and the other is charged positively. Both electrodes are then connected to one plate of a condenser in the output circuit of the electron tube, while the other plate of this condenser is maintained at a constant potential. The alternate charging of the two electrodes by the electron beam will then produce a saw-tooth potential variation on the one plate of the condenser, provided that the rate of charging of the two electrodes is correctly chosen.

The electrodes being both connected to one plate of the condenser can be mutually connected inside the tube, and hence it is possible to employ an electron tube of the type containing a metallic output anode which consists of or is coated with a substance having a high coefficient of secondary electron emission, said output anode comprising two parts, means for preventing electrons from leaving one of said parts, means for collecting electrons from the other part, and means for projecting onto said output anode an electron beam in order to produce output signals by the alternate charging and discharging of a condenser means. It is to be understood of course that the invention is not restricted to the use of this type of tube but it will however be convenient to describe the invention more fully with reference to a circuit employing such a tube.

Thus in the accompanying drawings Figure 1 shows a circuit according to the invention incorporating an electron tube of the type set forth above and Figures 2 and 3 show the variation in time of the input and output potentials and the position of the electron image in the tube shown in Figure 1. Fig. 4 is a circuit diagram of another embodiment of the invention; Fig. 5 is a graph, similar to Figs. 2 and 3, illustrating the performance of the Fig 4 circuit; and Figs. 6 and 7 are circuit diagrams of additional embodiments of the invention.

Referring now to Figure 1, R1 is an input resistance across which potential variations are developed in accordance with a periodic signal applied across the input terminals I. These potential variations are applied between earth U and the deflection plate P2 of an electron tube T, in which an electron beam is produced by a cathode B, a grid G, and a first anode A1, and is focussed in the region of the electrodes X and Y by a second anode A2. The potentials for the cathode, grid and anodes are obtained from the tappings V6, V7, V3 and V1 of the potentiometer W, the point V1 being preferably earthed. The cathode B is preferably a line-source of electrons, and the electron image is advantageously in the form of a very fine line parallel to the free edge of the electrode Y. The deflection plate P1 is connected to anode potential V1. An additional pair of deflection plates P3 and P4 is also provided in the tube. The plate P3 is connected to anode potential V1, while the plate P4 is connected to the variable tapping V2 of the potentiometer W. By adjustment of the tapping V2, the mean position of the electron image on the electrodes X and Y may be controlled. This adjustment could be effected by adjusting the potential of the plate P1 or P2, but the additional plates P3 and P4 have been described for the sake of clarity. The electrodes X and Y are the electrodes upon which the electron beam impinges, and are connected to one plate of the output condenser C0, which may be constituted by the deflection plates of a cathode ray oscillograph or the like. The other plate of this condenser is connected to the tapping V5 of the potentiometer. Adjacent to the electrode X is situated a grid S which is connected to the tapping V4 of the potentiometer W. The purpose of this grid is to prevent electrons from leaving the electrode X when the potential of X is more positive than that of S, so that X is charged negatively when the electron beam impinges thereon. Another grid E is situated adjacent to the grid S and the electrode Y. This serves to screen the remainder of the electron tube from the potentials of X, Y, S, and to collect secondary electrons emitted by the electrode Y, so that Y is charged positively when the electron beam impinges thereon. C4 and C5 are decoupling condensers.

The potential variations produced by the input signal on the plate P2 cause the electron image to travel across the electrodes X and Y in accordance with these potential variations. The mean position of the electron image is so adjusted that the image falls on the electrode X during the greater part of each cycle, and on the electrode Y for the remaining part, the width of the line electron image being sufficiently small that the time during which the image falls partly on each electrode is negligible. During the time that the electron image falls on X, the plate of the condenser C0 connected to X and Y is charged negatively by the electron beam, and its potential becomes more negative in a substantially linear function of time. During the time that the electron image falls on Y, the plate of the condenser C0 becomes likewise charged positively, and its potential becomes more positive in a substantially linear function of time. If the positive charging is made several times more rapid than the negative charging, then a saw-tooth potential variation is produced on the plate of the condenser C0 connected to X and Y, and as the other plate of the condenser is maintained at a constant potential, a saw-tooth potential variation is produced across the output terminals O connected across the condenser C0. The rapid positive charging is readily effected by providing Y with a surface possessing a high secondary emission coefficient. In principle the negative charging could be rapid and the positive charging less rapid, but this would be less convenient.

The processes involved are rendered clearer by Figure 2. Figure 2*a* shows the change of potential with time of the plate P2 due to an arbitrary periodic input signal. Figure 2*b* shows the change of position in time of the electron image falling on X or Y, due to the change of potential on P2. Figure 2*c* shows the corresponding potential change in time across the output terminals O.

Figure 2*c* is drawn on the assumption that the total positive charging of the plate Y is exactly equal to the total negative charging of the plate X in each cycle. It cannot in practice be assumed that the circuit as a whole, and in particular the potential variations of the input signal, will remain sufficiently constant to ensure that this adjustment is maintained. Accordingly in practice the positive charging of the plate Y is made sufficiently rapid to restore the potential of Y to its equilibrium value, which is substantially equal to the potential V1 of the grid E, before the negative charging of the plate X is due to commence. The potential across the output terminals O then follows a curve similar to that shown in Figure 2*d*. This ensures that the negative charging of the output condenser always starts from one definite potential and at one definite point of the cycle of the input potential variations.

It is evident that the form of the saw-tooth variation produced on the output is independent of the form of the input potential variations, provided that one selected portion of each cycle of the input potential variations and this portion only deflects the electron image onto the electrode Y. Also the amplitude of the output saw-tooth variation is independent of the amplitude of the input variations. Thus the circuit is applicable to the production of the line deflection saw-tooth variations necessary for a television cathode ray tube. In this case the electron image is deflected onto the electrode Y during the line synchronising pulses of the television signal, and is on the electrode X during the remainder of each line period. Figures 2*b* and 2*d* then take the form of Figures 3*b* and 3*d*. The deflection saw-tooth wave is thus automatically locked to the input picture signals, and furthermore no synchronising separating unit is required.

The amplitude of the saw-tooth wave at any frequency is proportional to the beam current of the electron tube T, and the required amplitude can therefore be obtained by adjusting the potential V7 of the grid G to the required value. In order that the electron image should fall on the electrode Y during the required part of the input cycle, it is necessary that its mean position should be suitably chosen; this is effected by suitably adjusting the potential V2 of the deflection plate P4.

The signal shown in Figure 2*a* may be a signal applied to a cathode ray oscillograph. In this case the saw-tooth potential oscillation shown in Figure 2*d* is applied to the horizontal deflection plates of the oscillograph. It will be observed, however, that the horizontal deflection is restored to its starting value after each cycle of the input signal, so that only one wave of the signal is shown on the screen of the oscillograph. It is frequently desirable to show on the oscillograph several waves of the signal. To effect this the modified circuit shown in Figure 4 may be employed. This circuit differs from that shown in Figure 1 in that the deflection plates P1 and P3 and the electrode E are not connected directly to the second anode potential V1. Instead the electrode E and the plate P1 are both connected through the variable resistance R2 to V1, and the plate P3 is connected to a point Z on the variable capacity bridge C1C2 which connects the plate P4 to the electrodes X and Y. C3 is an additional decoupling condenser. The potential V2 of the plate P4 is so adjusted that at the beginning of each sweep of the oscillograph the electron image lies on the electrode X throughout the whole of a cycle of the input potential variations. The electrodes X and Y are thus charged progressively in a negative sense. The capacity bridge C1C2 is in parallel with the capacity C0 of the output, and consequently is also charged negatively. The deflection plate P3 thus gradually acquires a more negative potential, thus deflecting the electron image towards the electrode Y. After a time interval depending on the selected value of the variable capacity C2 the electron image is so far deflected that during part of the cycle of the input potential variations it falls on the electrode Y. The output capacity C0 at once begins to acquire a more positive potential. The deflection plate P3 also acquires a more positive potential, which tends to deflect the electron image back onto the electrode X. This tendency would interrupt the positive charging before the electrodes X and Y regained their starting potential, but the secondary electrons emitted by the electrode Y are collected by the grid E, causing a current to flow through the resistance R2 so that the potential of the electrode E falls somewhat. This fall of potential is communicated to the deflection plate P1, causing the electron image to remain on the electrode Y until the electrodes X and Y regain a potential substantially equal to that of the electrode E. The current reaching E then suddenly decreases, the potential drop across the resistance R2 decreases likewise, the potential of the plate P1 rises, and the electron image returns to the plate X. The current reaching the grid E then ceases, the grid E regains second anode potential V1, and the cycle of operations is repeated. The variations in time of the input potential, the position of the electron image, the potential of the plate P1, and the output potential are shown respectively in Figures 5*a*, 5*b*, 5*c* and 5*d*. The number of cycles of the input potential variations shown on the oscillograph screen is controlled by the value of the capacity C2.

The circuit shown in Figure 4 can be modified in its details without affecting its fundamental mode of operation. For example the potential drop produced by the current through the grid E may be fed to the plate P3 instead of to the plate P1; also the capacity bridge C2C3 could be replaced by a resistive potentiometer. A circuit analogous to that shown in Figure 4 is applicable to the production of the frame-synchronising pulses for a television cathode ray tube. If synchronising signals of a special form are supplied, the frame-synchronising pulses can be produced by the circuit shown in Figure 1 in the same way as the line-synchronising pulses.

The circuit as already described produces a saw-tooth oscillation varying in a negative direction from a fixed potential. For some purposes, e. g., to produce the deflection of the cathode ray beam in a television cathode ray tube, it may be desirable to produce a saw-tooth variation of potential difference between two points having a constant mean potential. This involves producing one saw-tooth potential oscillation varying in a negative direction from a fixed potential and one saw-tooth potential oscillation varying in a positive direction from a fixed potential. These oscillations may be produced independently, or they may be developed from a single saw-tooth oscillation produced in the manner described above. The former procedure is the simpler, and will be described here.

It has hereinbefore been mentioned that the positive charging electrode Y (Figure 1) could be used to produce the slow change in the saw-tooth variation while the electrode X produces the rapid change. In this case the rate of charging of the electrode Y must be artificially limited, e. g., by exposing an area of this electrode to the electron image which is smaller than the image, so that only a part of the current in the electron beam reaches the electrode, or by feeding the input or output signals onto the grid G in such a way that the electron current is reduced during the time that the electron image falls on the electrode Y. This arrangement produces a saw-tooth potential oscillation varying in a positive direction from a fixed potential. By using one tube giving a variation in a positive direction and another tube giving a variation in a negative direction, an oscillation of the required form can be produced.

For the tube giving the positive variation it is advantageous to employ a modified form of output electrode system. Also the positive and negative variations may both be developed in one electron tube, having two output electrode systems each with its associated grid, but with the remaining components of the tube common to both systems. These modifications are shown in the circuit of Figure 6 wherein the electron tube T is shown in perspective section. The negative saw-tooth variation is produced on the electrode system XY by the action of the electron beam and the associated grids S and E exactly as described with reference to Figure 1, except that the grid E is preferably not connected to anode potential V1 but to a somewhat lower potential V8, while the grid E1 is connected to anode potential V1 to screen the remainder of the electron tube from the potentials of the output system. C8 is a decoupling condenser. The positive sawtooth variation is produced on the electrode Y1. This electrode is so positioned that the electron beam falls thereon whenever it falls on the electrode X. It has the property of emitting secondary electrons, which are collected by the grid E1, but its secondary emission coefficient is much smaller than that of the electrode Y. Consequently the electrode Y1 becomes charged more positively at a rate comparable with the rate at which the electrode X becomes charged negatively. When the electron beam falls on the electrode Y, it also falls on the electrode X1. This is connected to the tapping V14 of the potentiometer W; C14 is a decoupling condenser. The surface of X1 has a high secondary emission coefficient. The secondary electrons are prevented from reaching the grid E1 by the grid S1 which is connected to X1, and they are therefore collected by Y1, which is the most positive component near X1. Y1 is therefore charged rapidly in a negative direction by the numerous secondary electrons emitted from X1, producing the "flyback" of the positive sawtooth oscillation. The output capacity C0, which may be the capacity between the deflection plates of a television cathode ray tube, is connected between the electrode system XY and the electrode Y1. The relative amplitudes of the positive and negative oscillations may be controlled by varying the relative areas of the electron image making contact with the system X1Y1 and with the system XY respectively. This may be effected by applying a bias potential to two deflection plates, one of which is shown at P5 in Figure 6, to displace the mean position of the electron image along its length.

When the circuit of Figure 1 is employed. the progressive portion of the output sawtooth potential variation commences at the instant when the electron beam, moving under the influence of the input potential variation applied to the plate P2, crosses from the electrode Y on to the electrode X. The commencement of the progressive portion of the sawtooth potential variation is thus synchronized very exactly with the input potential variation. When the circuit of Figure 4 is employed, the progressive portion of the sawtooth potential variation commences when the electron beam crosses from the electrode Y to the electrode X due to the completion of the positive charging of the output capacity C0, the start of which charging was effected by the crossing of the electron beam from the electrode X on to the electrode Y under the influence of the input potential variations. The synchronisation of the output sawtooth potential variation with the input potential variation is thus less exact when the circuit of Figure 4 is employed than when the circuit of Figure 1 is employed. It has already been pointed out that, in order to produce the frame deflection of a television cathode ray tube, the circuit of Figure 1 can only be employed if the television signal is of a special form, this form being that the frame synchronising impulses are of a lower level than the line synchronising impulses. The use of the circuit of Figure 4, as hitherto suggested, when signals of the type usually transmitted in present day television practice are available, is less desirable due to its less exact synchronising properties. It is, however, possible to modify the circuit of Figure 1 in such a way as to produce the required frame deflection sawtooth potential variation without loss of the exact synchronising properties of Figure 1. The modification can be applied, with the necessary additions, to the circuit of Figure 6, which is essentially a more elaborate form of the circuit of Figure 1.

The modification consists of the employment of a duplicate output electrode system, with the line of demarkation between the positive charging and negative charging electrodes in the two pairs mutually displaced. One of these output electrode systems produces the frame deflection sawtooth potential variation, while the other system feeds an auxiliary signal on to a deflection plate of the electron tube during the synchronising pulses of the television signal. The electron beam oscillates across one electrode of the main electrode system during the frame scan of the television signal. During the synchronising pulses the signal from the auxiliary electrode system deflects the beam towards the other electrode of the main electrode system. The beam does not reach this other electrode during the line synchronising pulses, but does so during the frame synchronising pulses, and then produces the flyback of the frame deflection sawtooth potential variation. The auxiliary electrode system may advantageously also produce the line deflection sawtooth potential variation for the television cathode ray tube. A circuit arranged to this effect is shown in Figure 7 in perspective section. The circuit in Figure 7 is the same as that of Figure 1 except in that the output electrode system is in duplicate, the plate P3 is connected through the resistance R3 to second anode potential V1 and is also connected to the auxiliary electrode Q, and an additional pair of deflection plates, one of which is shown at P5, is provided in the electron tube. The components which are operative in producing the frame deflection sawtooth potential variation are suffixed with the letter F, and those which are operative in producing the line deflection sawtooth potential variation are suffixed with the letter L. The edges of the effective portions of the electrodes XL and XF are shown by dotted lines in order to emphasise the relative displacement of the two electrode systems.

During the part of the input television picture signal which contains the picture intelligence, the electron beam falls on the negative charging electrodes XL and XF, producing the progressive part of the line and frame deflection sawtooth variations. During each line synchronising pulse, the electron beam is deflected to fall on the positive charging electrode YL, producing the flyback of the line deflection, but the deflection is not sufficient to cause the beam to fall on YF, so the formation of the progressive portion of the frame sawtooth deflection continues. Part of the secondary electrons emitted by the electrode YL during the synchronising pulses are collected by the auxiliary electrode Q, and begin to charge the plate P3 negatively. This deflects the electron beam towards the electrode YF, but not far enough to fall thereon. After each pulse, the plate P3 regains second anode potential V1 through the resistance R3. The frame synchronising pulses in present day television transmission are distinguished from the line synchronising pulses by being of longer duration. During these pulses the plate P3 is charged sufficiently to deflect the electron beam on to the electrode YF, producing the flyback of the frame deflection sawtooth variation. The beam remains on the plate YF until the end of the frame synchronising pulses, when it immediately returns to the electrodes XF and XL, to produce the progressive portions of both sawtooth variations. The commencement of these progressive portions is thus synchronised very exactly with the input television signal.

The rate of charging of the electrode XF must essentially be much slower than that of XL. This may be effected by making the area of XF in contact with the electron beam much less than that of XL; the output capacity C0F may also be artificially increased to reduce the rate of charging. The relative amplitudes of line and frame deflection can be controlled by adjusting the relative areas of XL and XF in contact with the electron beam or by adjusting the output capacities C0F and/or C0L, the first being effected by applying to the aforementioned additional pair of deflection plates of the electron tube, one of which is shown at P5 in Figure 7, a suitable difference of potential.

There are various ways by which a signal from the auxiliary electrode system can be fed on to a deflection plate of the electron tube, and the invention is not confined to the method described with reference to Figure 7.

What we claim and desire to secure by Letters Patent is:

1. In operating a cathode ray tube device under the control of an electric signal having two periodic signal components established at different amplitude levels, one of which pertains to the frequency at which the electron beam of said cathode ray tube device is to be deflected, the method of generating beam deflecting potentials of triangular form which consists in utilising one of said signal components to control the charging of a condenser means and utilising the other signal component to discharge said condenser means over a period of time greater than one complete cycle of said signal components.

2. In the reception of television signals which comprise synchronising components and video components, the method of generating potential variations of saw tooth form for controlling the deflection of the cathode ray beam of a picture reconstituting means, which consists in utilising one of said signal components to control the charging of a condenser means and utilising the other signal component to discharge said condenser means over a period of time greater than one complete cycle of said signal components.

3. In or for a wave generating system adapted to produce electric potential variations of triangular form, said wave generating system including a cathode ray tube device having electrode means with sections connected to a condenser and adapted to be charged in opposite sense by an electron beam under control of a periodically varying electric signal; the method which comprises deflecting the electron beam upon one section of the electrode means by the electric signal to charge a condenser, progressively deflecting the electron beam towards the other section of the electrode means by the increasing charge of the condenser, discharging the condenser by the impact of the electron beam on said other section of the electrode means, whereby the electron beam tends to return to the first section of the electrode means, and delaying such return of the electron beam by a potential drop developed by secondary emission from said other section of the electron means.

4. In or for a wave generating system adapted to produce electric potential variations of saw tooth form suitable for effecting the deflection of the cathode ray beam of a cathode ray tube device adapted to respond to the effect of electric signals having two periodic signal components established at different amplitude levels and of different duration, an electron tube means having input electrodes to which said composite signal is adapted to be applied, output electrode means responsive to one of said signal components to bring about the charging of a condenser means and to the other signal component to bring about the discharging of said condenser

means, and means cooperating with said output electrode means to continue the discharging of said condenser means for a period of time greater than the duration of one cycle of said signal.

5. Means for generating electric waves of triangular form in response to electric signals having two periodic signal components established at different amplitude levels, comprising an electron tube means which includes control electrode means to which the composite signal is adapted to be applied, electrode means adapted to be electrically charged by an electron beam under the control of said control electrode means, said chargeable electrode means comprises two electrodes each presenting a surface having a secondary electron emission greater than unity, an auxiliary electrode adjacent one of said electrodes to collect secondary electrons from the electrode, and an auxiliary electrode adjacent the other electrode to prevent secondary electrons from leaving the same, whereby one signal component serves to bring about the electrical charging of the said chargeable electrode means and the other signal component serves to bring about the discharging of said electrode means.

6. In apparatus for the production of a sawtooth or trapezoidal potential variation, electron tube means comprising a pair of electrodes having secondary electron emission coefficients greater than unity, means for establishing an electron beam, a pair of beam deflecting plates, means for directing the electron beam on to one of said electrodes, auxiliary electrode means adjacent the said electrode to prevent secondary electrons from leaving the same, whereby the progressive portion of the potential variation is produced by the charging of the said electrode, means for deflecting the electron beam on to the other electrode of said pair of electrodes, auxiliary electrode means adjacent said other electrode to collect secondary electrons emitted therefrom, whereby the flyback portion of the potential variation is produced by the charging of said other electrode, and means coupling said last mentioned auxiliary electrode means to one of said deflecting plates to impress thereon a beam-deflecting voltage that retains the electron beam upon said other electrode until the flyback portion of the potential variation is completed.

7. An electrical circuit including an electron tube containing a pair of electrodes, a pair of deflection plates, means for projecting an electron beam onto either of said electrodes, and means for applying to said deflection plates a periodic potential variation of arbitrary form to project said electron beam onto one of said electrodes during one portion of one cycle of each series of a selected number of cycles of the periodic potential variation and to project said electron beam onto the other electrode during substantially the whole of the remainder of said cycle and during substantially the whole of any remaining cycles of said series of said selected number of cycles, thereby producing across an output capacity connected to one of said electrodes a saw tooth potential variation of frequency equal to the frequency at which said electron beam is projected onto either of said electrodes and synchronised with said periodic potential variation applied to the deflection plates.

8. An electrical circuit including an electron tube containing a pair of electrodes and a pair of deflection plates, means for projecting an electron beam onto either of said electrodes, means for applying to said deflection plates a periodic potential variation of arbitrary form whereby said electron beam is caused to oscillate over one of said electrodes during the whole of all the cycles but one of a series of a selected number of cycles of the periodic potential variation and during part of the remaining cycle of said series thereby producing across an output capacity connected to one of said electrodes the progressive portion of a saw tooth potential variation, an impedance bridge connecting said electrode to a deflection plate whereby the electron beam is moved progressively so that during the remainder of said remaining cycle of said series it falls on the other electrode thereby producing the flyback of the saw tooth potential variation, and means for feeding a signal onto a deflection plate during said remainder of said remaining cycle until the production of the flyback of the saw tooth potential variation is completed.

9. An electrical circuit including an electron tube containing two pairs of electrodes and a pair of deflection plates, means for projecting an electron beam onto either electrode of each pair of electrodes, and means for applying to said deflection plates a periodic potential variation of arbitrary form to deflect said electron beam onto one electrode of each pair of electrodes during one portion of a cycle of the periodic potential variation and onto the other electrode of each pair of electrodes during substantially the whole of the remainder of said cycle, thereby producing across an output capacity connected between one electrode of one pair of electrodes and the corresponding electrode of the other pair of electrodes a saw tooth variation of potential difference of substantially constant mean potential, said saw tooth variation being of the same frequency as the applied periodic potential variation and synchronised therewith.

10. An electrical circuit including an electron tube containing a pair of electrodes with secondary emission surfaces and auxiliary electrodes cooperating with said electrodes for charging the same in opposite sense when impinged upon by an electron beam, a pair of deflection plates means for projecting an electron beam onto either of said electrodes, a condenser connected to said electrodes, and means for applying to said deflection plates a television picture signal including periodic picture intelligence components and frame synchronizing pulses of different amplitudes, whereby said electron beam is projected onto one of said electrodes during the frame synchronising pulses of each frame period and is projected onto the other electrode during the remainder of each frame period, thereby producing across the condenser a saw tooth potential variation synchronised with the frame synchronising pulses of the television picture signal.

11. An electrical circuit including for developing line and frame scan voltages from a television picture signal having a picture intelligence component and periodic synchronizing pulses of line and frame scan frequencies, the frame synchronizing pulses being of longer time period than the line synchronizing pulses, said circuit comprising an electron tube containing two pairs of electrodes and a pair of deflection plates, means for projecting an electron beam onto either electrode of each pair of electrodes, a condenser connected to the electrodes of each of said pairs, and means for applying to said deflection plates a television picture signal to de-

flect said electron beam onto one electrode of each pair of electrodes during the frame synchronising pulses of each frame period and onto said one electrode of one pair of electrodes during the line synchronizing pulses, the picture intelligence components deflecting said electron beam onto the other electrode of each pair of electrodes during the remainder of each frame period thereby producing saw tooth variations of potentials across said condensers that are available for producing the line and the frame scan of a television cathode ray tube.

12. An electrical circuit including an electron tube containing a pair of electrodes and a pair of deflection plates, means for projecting an electron beam onto either of said electrodes, a condenser connected to said electrodes, means for applying to said deflection means a television picture signal including picture intelligence components and frame synchronizing pulses of different amplitudes, to oscillate said electron beam over one of said electrodes during the whole of that part of each frame scan which contains the picture intelligence thereby producing across the condenser the progressive portion of a saw tooth potential variation, an impedance bridge connecting that electrode to one of said deflecting plates to displace the electron beam towards the other electrode, the frame synchronizing pulses effecting further beam displacement whereby during the frame synchronising pulses of each frame scan it falls on the other electrode thereby producing the flyback of the sawtooth potential variation, and means cooperating with said other electrode for feeding a signal onto a deflection plate of the electron tube during said frame synchronising pulses until the production of the flyback of the sawtooth potential variation is completed, said sawtooth potential variation being thereby synchronised with the television picture signal and available for producing the frame scan of a television cathode ray tube.

13. In a receiver for television signals of the type including picture intelligence components and periodic line and frame synchronizing pulses of amplitude levels differing from that of the picture intelligence components; the combination with an electron tube containing means for producing an electron beam, electrode means having sections upon which said electron beam may impinge, and deflection means for displacing the electron beam, of a condenser connected to said electrode means to be charged or discharged in accordance with the section of said electrode means upon which the electron beam impinges, means for impressing a television signal upon deflection means, means for applying to said deflection means energizing potentials to establish a normal electron beam path selectively displaceable by picture intelligence components and synchronizing pulses on to different sections of said electron means, and means responsive to the charge developed upon one section of said electrode means for imposing a direct current potential on said deflection means.

14. In a receiver for television signals of the type including picture intelligence components and periodic line and frame synchronizing pulses of amplitude levels differing from that of the picture intelligence components; the combination with an electron tube containing means for producing an electron beam, a pair of electrode means each having two sections upon which the electron beam may impinge, and deflection means for displacing the electron beam with respect to the electrode means, of a line scan condenser connected to one electrode means, a frame scan condenser connected to the other electrode means, means for impressing a television signal upon said deflection means, means applying energizing potentials to said deflection means to establish a normal electron beam path selectively displaceable by picture intelligence components on to one section of each of said electrode means and by the respective synchronizing pulses on to the other sections of the electrode means associated with the line scan and the frame scan condensers.

15. In a receiver for television signals of the type including picture intelligence components and periodic line and frame synchronizing pulses of amplitude levels differing from that of the picture intelligence components; the combination with an electron tube containing means for producing an electron beam, a pair of electrode means each having two sections upon which the electron beam may impinge, and deflection means for displacing the electron beam with respect to the electrode means, of a line scan condenser connected to one electrode means, a frame scan condenser connected to the other electrode means, means for impressing a television signal upon said deflection means, means applying energizing potentials to said deflection means to establish a normal electron beam path selectively displaceable by picture intelligence components on to one section of each of said electrode means and by line synchronizing pulses on to the other section of the electrode means connected to the line scan condenser, and means energized by impact of the electron beam on said other section of the electrode means connected to the line scan condenser to develop on said deflection means a potential to displace the electron beam towards the other section of the electrode means connected to the frame scan condenser.

16. In a receiver for television signals of the type including picture intelligence components and periodic line and frame synchronizing pulses of amplitude levels differing from that of the picture intelligence components; the combination with an electron tube containing means for producing an electron beam, a pair of electrode means each having two sections upon which the electron beam may impinge, and deflection means for displacing the electron beam with respect to the electrode means, of a line scan condenser connected to one electrode means, a frame scan condenser connected to the other electrode means, means for impressing a television signal upon said deflection means, means applying energizing potentials to said deflection means to establish a normal electron beam path selectively displaceable by picture intelligence components on to one section of each of said electrode means, and by line synchronizing and frame synchronizing pulses on to the other section of the electrode means connected to the line scan condenser, and means energized by impact of the electron beam on said other section of the electrode means connected to the line scan condenser to develop on said deflection means a progressively increasing potential to displace the electron beam towards the other section of the electrode means connected to the frame scan condenser, the frame synchronizing pulses of the television signal being of longer duration than the line scanning pulses, whereby the electron beam is displaced to impinge upon the other section of the electrode means connected to the frame scan

condenser when frame synchronizing pulses are impressed upon said deflection means.

17. In a receiver for television signals, the invention as recited in claim 16, in combination with means energized by impingement of the electron beam on the other section of the electrode means connected to said frame scan condenser for imposing on said deflection means a potential that delays the displacement of the electron beam from said other section of the electrode means connected to said frame scan condenser.

18. An electrical circuit including an electron tube containing a pair of electrodes and a pair of deflection plates, an output capacity connected to said electrodes, means for projecting an electron beam onto either of said electrodes, means for applying to said deflection plates a periodic potential variation of arbitrary form to project said electron beam onto one of said electrodes during a plurality of cycles of each series of a selected number of cycles of the periodic potential variation thereby charging both electrodes in one sense by secondary emission from the first electrode, and deflection means energized by the charge accumulated by said charging of the electrodes to project the electron beam onto the other electrode during substantially the whole of the remainder of a portion of the final cycle of said series of said selected number of cycles thereby charging both electrodes in the opposite sense, thereby producing across said output capacity a sawtooth potential variation of frequency equal to the frequency at which said electron beam is projected onto either of said electrodes and synchronised with said periodic potential variation applied to the deflection plates.

19. An electrical circuit including an electron tube containing a pair of electrodes and a pair of deflection plates, an output capacity connected to said electrodes, means for projecting an electron beam onto either of said electrodes, means for applying to said deflection plates a periodic potential variation of arbitrary form to project said electron beam onto one of said electrodes during a plurality of cycles of each series of a selected number of cycles of the periodic potential variation thereby charging the other electrode positively by secondary emission from the first electrode, and deflection means energized by the charge accumulated by said electrodes to project the electron beam onto said other electrode during substantially the whole of the remainder of a portion of the final cycle of said series of said selected number of cycles thereby charging said other electrode positively by secondary emission therefrom, thereby producing across the output capacity a saw tooth potential variation of frequency equal to the frequency at which said electron beam is projected onto either of said electrodes and synchronised with said periodic potential variation applied to the deflection plates.

20. An electron tube including a pair of electrodes each having surfaces with a secondary emission coefficient greater than unity, a pair of deflection plates, and means for projecting an electron beam onto either of said electrodes so that, when an electric potential variation is applied to said deflection plates, the electron beam makes contact alternately with the two electrodes, thereby establishing a potential variation on one of said electrodes by alternately charging said electrode positively by secondary emission therefrom and charging said electrode negatively by secondary emission from the other electrode.

21. An electron tube including two pairs of electrodes and a pair of deflection plates, and means for projecting an electron beam onto either of said electrodes of each pair of electrodes so that, when an electric potential variation is applied to said deflection plates, the electron beam makes contact alternately with the two electrodes of each pair of electrodes, thereby establishing a potential variation on one of said electrodes of each pair of electrodes by alternately charging said electrode of one pair of electrodes positively by secondary emission therefrom while charging said electrode of the other pair of electrodes negatively, and charging said electrode of the first mentioned pair of electrodes negatively by secondary emission from the other electrode of that pair of electrodes while charging said electrode of said other pair of electrodes positively by secondary emission therefrom, said potential variation established on the electrode of one pair of electrodes being in opposite phase to the potential variation established on the electrode of the other pair of electrodes.

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