

April 30, 1935.

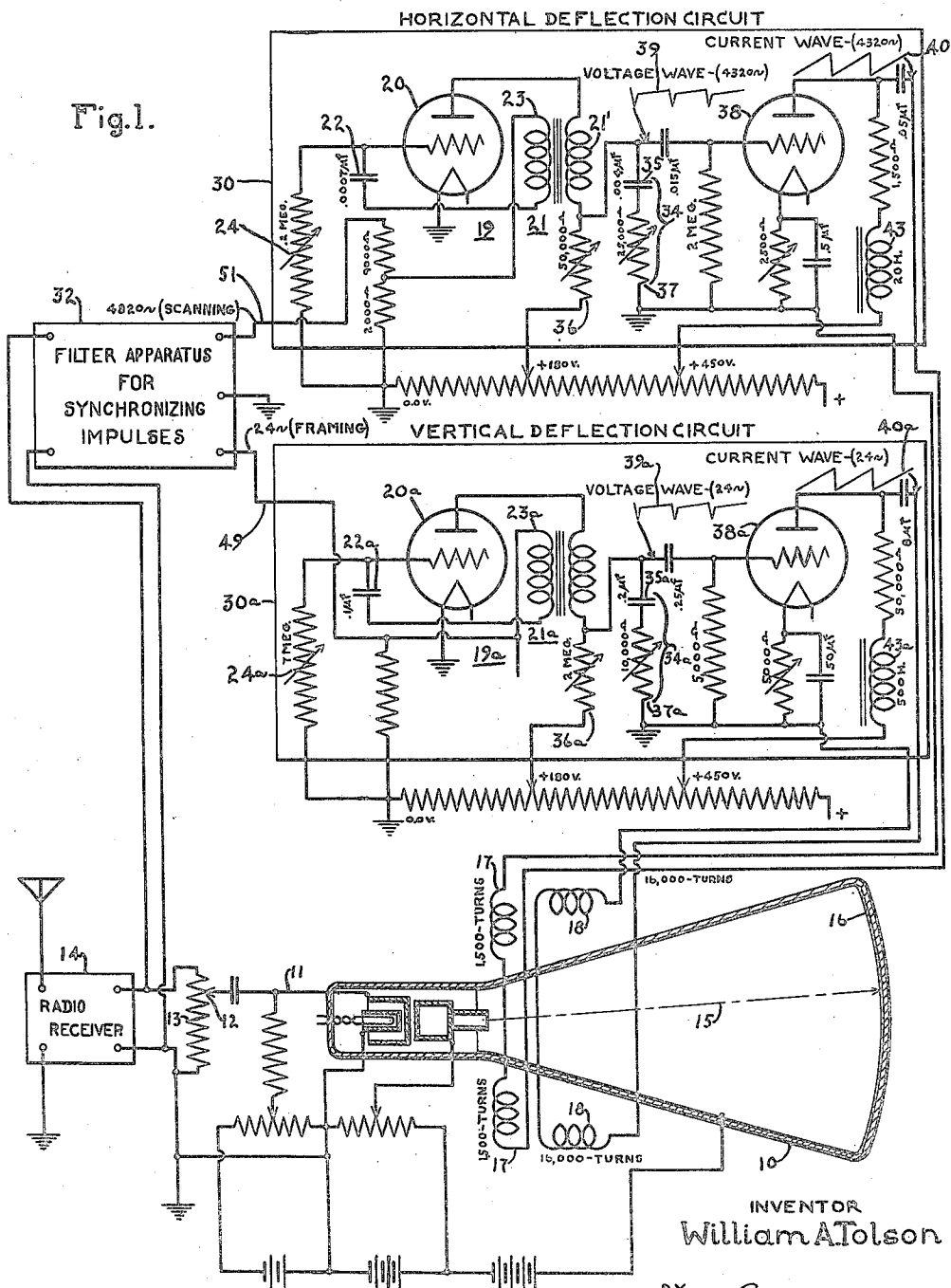
W. A. TOLSON

1,999,378

TELEVISION SYSTEM

Filed April 30, 1932

2 Sheets-Sheet 1



INVENTOR  
William A Tolson

BY *JR Goldborough*  
HIS ATTORNEY

April 30, 1935.

W. A. TOLSON

1,999,378

TELEVISION SYSTEM

Filed April 30, 1932

2 Sheets-Sheet 2

Fig. 2.

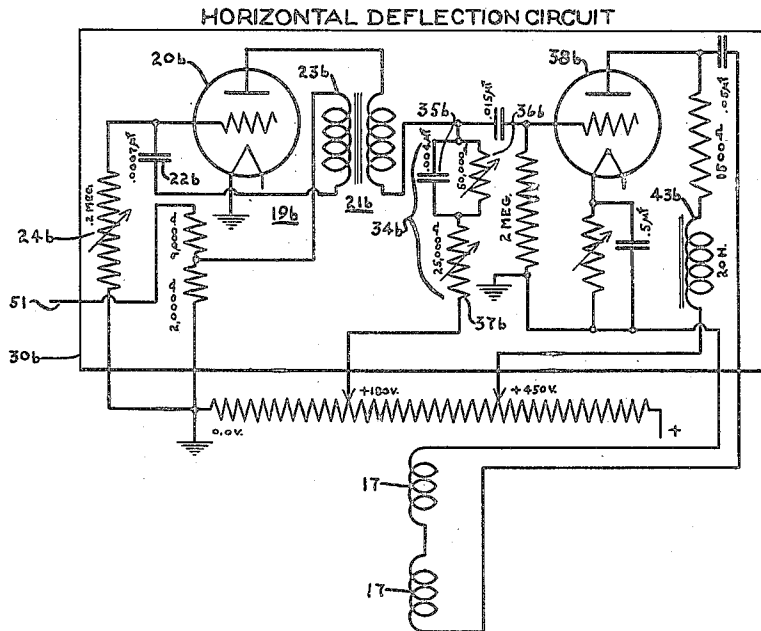
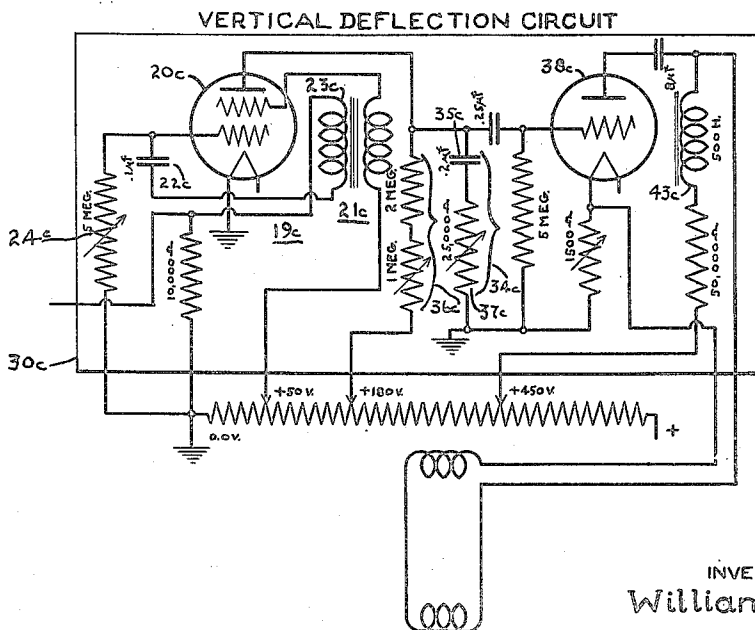


Fig. 3.



INVENTOR

William A. Tolson

BY

*R. H. Robinson*  
HIS ATTORNEY

## UNITED STATES PATENT OFFICE

1,999,378

## TELEVISION SYSTEM

William A. Tolson, Erlton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application April 30, 1932, Serial No. 608,460

REISSUED

8 Claims. (Cl. 250—36)

My invention relates to improvements in television systems embodying a cathode ray tube or other equivalent electron device at either or both the transmitting and receiving stations, and, more particularly, to improved apparatus for deflecting the electrons, in such tubes or devices, for scanning purposes.

Television receiving systems of the general character as that disclosed in the copending application by Arthur W. Vance, Serial No. 544,959, filed June 17, 1931, and assigned to the Radio Corporation of America, comprise a cathode ray tube with horizontal and vertical ray-deflecting coils, a horizontal deflection system for causing a saw-tooth current wave at the desired line-scanning frequency to pass through the horizontal ray-deflecting coils, and a vertical deflection system for causing a saw-tooth current wave at the desired framing frequency to pass through the vertical ray-deflecting coils.

For the purpose of synchronization, a dynatron oscillator is utilized to generate sharp voltage peaks, in the plate circuit thereof, and its oscillation frequency is locked in step with operating action at the transmitting station by transmitted synchronizing impulses which are applied to the grid circuit of the dynatron. The tips of the voltage peaks referred to, which occur at the ends of the scanning periods, are utilized to drive the horizontal deflection system which includes a condenser discharged by a tube having its grid circuit supplied from the plate circuit of the dynatron. The condenser-discharge tube is so biased that it draws plate current only at the level of the tips of the voltage peaks referred to.

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 dynatron oscillator is directly controlled by the applied plate and screen-grid voltages. Relatively small variations in supply voltages, therefore, are effective to change the frequency sufficiently to throw the system out of synchronism. Furthermore, in these systems, the deflecting circuits embody a relatively large number of tubes and, still further, adjustments for obtaining the desired wave shape are accompanied by some degree of frequency change. This necessitates other adjustments and readjustments until the desired operating conditions are obtained.

With the foregoing in mind, it is one of the objects of my invention to provide an improved television system of the character referred to embodying an oscillator circuit which not only gen-

erates a sharply-peaked output voltage wave, but which also maintains its required frequency of oscillations independently of occurring variations in the supply voltages over a range usually met with in practice.

Another object is the provision of an improved deflecting circuit particularly adaptable for causing a saw-tooth current wave to pass through electromagnetic deflecting coils for a cathode ray tube, which circuit comprises only two tubes for this purpose, and which can be adjusted to obtain the required wave shape without affecting the frequency of operation.

Other objects and advantages will hereinafter appear.

In accordance with my invention, for horizontal deflection of the cathode ray, a coupled oscillator tube is used. A resistance and a condenser are connected in the grid circuit, the capacity of the condenser being such that the charge which it stores up during the first oscillation is effective at substantially the completion thereof to block the tube against further oscillations by supplying a bias potential to the grid more negative than the cut-off potential.

At this point in the operating cycle, the resistance is effective to provide a leakage path for the charge, the rate of leakage, however, being such that the period of time elapsing before the bias becomes sufficiently less negative that it reaches a magnitude approximating that of the cut-off potential or slightly below it, is of the order of ten to twenty times the period of the first, single oscillation, the sum of the two periods being equal to a scanning-line period. There occurs, therefore, only a single, sharply-peaked current impulse in the plate circuit only once during each scanning-line period, and these are utilized to generate a saw-tooth current wave at the scanning-line frequency.

For vertical deflection of the cathode ray, a similar oscillation circuit is embodied in the vertical deflection system for generating a saw-tooth current wave at the framing frequency.

For the purpose of synchronization, the capacity of the blocking condenser and the value of the grid-leak resistance in each circuit are such that, at the end of the operating cycle, the bias on the grid is still slightly more negative than the bias necessary for cut-off, at which time a received synchronizing or framing impulse applied to the grid is effective to bring the bias at least to or slightly less than the cut-off potential. In this manner, the received synchronizing and framing impulses are effective to cause the operating

cycles to begin at the same point at the end of each scanning-line period or each frame, as the case might be.

A television system constructed and operating in the specific manner just explained is disclosed in my copending joint application with Justin R. Duncan, filed February 27, 1932, and bearing Serial No. 595,484.

My invention resides in a system and method of operation of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawings, wherein

Figure 1 is a diagrammatic view of a television receiving system embodying my invention; and

Figs. 2 and 3 are diagrammatic views showing modifications of the system illustrated in Fig. 1.

In Fig. 1, the various parts, circuits and connections have, for convenience of comparison, been designated by the same reference numerals designating the respective and corresponding parts, circuits and connections in my copending application referred to.

The particular embodiment of my invention shown in Fig. 1 comprises a cathode ray tube 10 having its control-grid circuit supplied with picture signals by way of a connection 11 terminating at an adjustable contact 12 associated with a resistance 13, the latter being connected across the output of a suitable radio receiver 14.

A cathode ray 15 is caused to scan a fluorescent screen 16 by electromagnetic coils 17 for deflecting the ray horizontally, and by electromagnetic coils 18 for deflecting the ray vertically. For this purpose, the horizontal deflection circuit shown, and designated generally by the reference numeral 30, generates a saw-tooth current wave at a suitable line-scanning frequency, for example, 4320 cycles for a picture having 180 lines and for 24 frames a second, and supplies this wave to the coils 17. In like manner, the vertical deflection circuit shown generates a saw-tooth current wave at the framing frequency, for example, 24 cycles, and supplies this wave to the coils 18.

The horizontal deflection circuit includes an oscillator circuit 19 comprising an electron tube 20 and a transformer 21 providing an inductive coupling between the plate and grid circuits. A blocking condenser 22 is connected as shown between the grid of the tube 20 and the grid winding 23 of the transformer. An adjustable resistance 24 provides a leakage path to ground for the electrical charge stored in the condenser 22, as will hereinafter more fully appear.

The manner of operation of the oscillator circuit 19 will now be explained. At the start of the operating cycle, the plate current increases, and the polarity of the grid winding 23 of the oscillation transformer is such that the grid is then driven positive. This action is effective to increase the plate current still further until a condition of saturation is reached, after which the plate current begins to decrease. From this point, the plate current decreases almost instantaneously to zero by reason of the fact that, at the instant the plate current begins to decrease, the polarity of the grid is reversed by the action of the transformer windings 21' and 23 with respect to each other. This drives the grid almost instantaneously to a negative potential far below that necessary for cut-off.

During the action just described, the grid draws current for a very short period, and a negative charge is, accordingly, stored in the

condenser 22. The charge stored by the condenser is not appreciably affected by the resistance 24 because the latter is relatively high compared to the resistance between the grid and cathode. The negative charge stored in the condenser blocks the tube against further oscillation, because this charge places on the grid a negative potential much greater than that required for cut-off. This negative charge, therefore, must be reduced by leakage through the resistance 24, before the plate can again begin to draw current to start the next cycle of operation. The time required for this discharge is determined by the ratio existing between the value of the resistance 24 and the capacity of the condenser 22. This ratio is made such that, at the end of the complete operating period, which equals a scanning-line period, the charge will not have leaked off sufficiently to reduce the negative bias quite to a potential such that the plate can again begin to draw current. At this instant, however, a sharp synchronizing impulse is received, and this is effective to counteract the bias potential on the grid sufficiently to permit space current to flow, thus initiating the next succeeding operating cycle.

By exciting the grid circuit from the plate circuit, and by using the proper values of capacity and resistance, the oscillator circuit is permitted to make only one oscillation during each complete operating period. Only a single, sharp impulse of current therefore passes through the plate circuit during each complete operating period, and this impulse, under the control of the received synchronizing impulses, always occurs exactly during the same part of the operating periods. In the particular embodiment shown, the capacity of the blocking condenser 22 and the value of the associated resistance 24 are such that the period during which the plate of the tube 20 draws current is about one-tenth of the entire operating period of the oscillator circuit.

The current impulses developed in the plate circuit of the tube 20, as just explained, cause a saw-tooth voltage wave to appear across a condenser 35 and an impulse voltage wave to appear across a resistance 37, the condenser 35 and the resistance 37 being connected in series relation with respect to each other and comprising a network 34 connected in the plate circuit of the tube 20. The saw-tooth voltage wave appearing across the condenser 35 is attributed to the fact that the condenser is charged linearly through the relatively high resistance 36 connected to the potential supply source shown, and to the fact that, when the charge reaches a definite level, the condenser is discharged practically instantaneously by the sharp impulse of current which then passes through the tube 20. The saw-tooth voltage wave across the condenser 35 and the impulse voltage wave across the resistance 37 combine to form, across the network 34 and in the output circuit of the tube 20, a voltage wave 39 having a frequency of 4320 cycles. The voltage wave 39 is of the shape required to cause a saw-tooth current wave to pass through an inductive circuit. The wave 39, therefore, is amplified by a suitable amplifier tube 38 having its input circuit connected directly, as shown, to the output circuit of the tube 20, and having its output circuit connected to the horizontal deflecting coils 17 through which a saw-tooth current wave at 4320 cycles is caused to pass.

The vertical deflection circuit 30a operates in the same manner as the horizontal deflection circuit, and the various parts making up the former have been designated by the same reference numerals, with the suffix "a", as the respective and corresponding parts comprising the horizontal deflection circuit. In the circuit 30a the capacity of the blocking condenser 22a and the value of the associated resistance 24a are such that the period during which the plate of the tube 20a draws current is about one-fiftieth of the entire operating period of the oscillator circuit 19a. The circuit 30a causes a saw-tooth current wave 40a to pass through the vertical deflecting coils 18, and this wave is at 24 cycles as determined by the received framing impulses occurring at the rate of 24 a second and applied to the grid circuit of the tube 20a by the connection 49.

The ratios of the transformers 21 and 21a are such as to obtain the required amplitude of horizontal and vertical deflection of the ray 15. These ratios, however, are not critical.

In the specific embodiment of my invention disclosed in Fig. 1, it is intended that the transformer 21 be a two-to-one step-down transformer from plate to grid, and that the transformer 21a be a two-to-one step-up from plate to grid. In this embodiment, also, it is intended that the natural oscillation period of the windings of the transformer 21 be such that the time period of one-half cycle is less than one-tenth of a scanning-line period, and that the natural oscillation period of the transformer 21a be such that the time period of one-half cycle be about one-fiftieth of the frame period.

In describing the manner of operation of the embodiment of my invention disclosed in Fig. 1, it has been assumed, for example, that the picture signals and the synchronizing impulses are being transmitted in the same manner and by a transmitting system of the general character disclosed in the copending application of Ray D. Kell, filed September 30, 1931, bearing Serial No. 565,953, and assigned to the Radio Corporation of America. In such a system, the picture signals and the synchronizing impulses are transmitted in the same channel, with the impulses at a substantially greater amplitude than the picture signals. Both the horizontal and vertical impulses are transmitted at the same amplitude, but are of different shapes so that these impulses have substantially different steepness of wave fronts. The horizontal impulses are transmitted at the end of each picture line, and occur at the rate of 4320 a second, while the vertical impulses are transmitted at the end of each frame and occur at the rate of 24 a second.

At the receiving station, the picture signals and the synchronizing impulses appear across the resistance 13 in the form of a single wave. This wave is supplied to the input circuit of a suitable filter apparatus 32 which blocks the picture signals but passes the synchronizing impulses which are of substantially greater amplitude than the latter, as explained. The apparatus 32 is effective to distinguish between the horizontal and vertical impulses, and passes the former to the grid circuit of the tube 20 by way of a connection 51, and passes the latter to the grid circuit of the tube 20a by way of a connection 49.

As a possible modification, the resistance 36 may be so connected in shunt with the condenser 35 that this resistance then forms part of the network 34. Such a modification is shown in

Fig. 2, wherein the various parts have been designated by the same reference numerals with the suffix "b" as the respective and corresponding parts comprising the circuit 30 in Fig. 1. The operating action of the circuit 30b is the same as that of the circuit 30. That is, the oscillator 19b operates to develop across the network 34b a voltage wave comprising a saw-tooth component, which appears across the condenser 35b and the resistance 36b, and an impulse component which appears across the resistance 37b. The modified circuit in Fig. 2 may also be used for the vertical deflection circuit 30a in Fig. 1.

Fig. 3 shows a modification wherein a screen-grid tube 20c is substituted for the tube 20a in the vertical deflection circuit 30a in Fig. 1. In this modification, the oscillating circuit is comprised of the screen grid, the grid and the cathode of the tube 20c, the screen-grid acting as a plate. The output circuit of the tube 20c is comprised of the plate and the cathode, with the screen grid acting as a control grid. The connections and manner of operation are, otherwise, the same as in the circuit 30a. The advantage of the circuit 30c is that the oscillator circuit 19c, due to the electronic coupling in the tube 20c, oscillates entirely independently of any other operating action in the entire circuit, and for this reason any adjustments or changes which might be made in the network 34c, to change the ratio of saw-tooth component to impulse component, will have no influence to cause a change in the frequency of operation of the oscillator circuit 19c.

The circuit in Fig. 3 may be modified by interchanging the respective connections to the plate and the screen grid of the tube 20c. In such case, the oscillating circuit will be comprised of the cathode, the grid and the plate, and the output circuit of this tube will be comprised of the cathode and the screen grid. The output circuit, in this modification, may be controlled by either the control grid or the plate, as might be found desirable on account of the mechanical construction of the tube.

In Fig. 1, the tube 20 may also be replaced by a screen-grid tube, as described in connection with Fig. 3.

My improved oscillator circuits 19, 19a, 19b and 19c may be used for many other purposes than the synchronization of deflection circuits in a television system. There is a great variety of commercial control systems requiring that a single, sharply-peaked control impulse reoccur faithfully at the beginning or ending of a definite time period. For example, in the art of maintaining clocks in exact synchronism with observatory time, a single, sharply-peaked control impulse reoccurring once at the same instant during minute periods, would be effective for this purpose. In such case, for example, the resistance 24 and the condenser 22 in the oscillator circuit 19 would be adjusted so that the complete operating period would be substantially one minute, and the received synchronizing impulses, for making this period exactly one minute, would correspond to the received timing impulses under control of the master clock.

The various values of resistance, capacity, inductance and voltage designated in the drawings have been found to provide for very satisfactory operation. However, these values are not critical in any strict sense of the word, and may be varied over a substantial range. Furthermore, in this connection, various other changes might be made such as in the circuit arrangement without

departing from the spirit of the invention or the scope of the claims.

I claim as my invention:

1. In an electrical circuit for developing a voltage wave comprising a saw-tooth component and an impulse component, an electron tube having its input circuit excited from its output circuit in such manner that as the plate current increases the bias on the grid of said tube increases in the positive sense and as the plate current decreases such bias increases in the negative sense, and an electrical network connected in the output circuit of said tube and comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears.

2. In an electrical circuit for developing a voltage wave comprising a saw-tooth component and an impulse component, a tube having an input circuit constituting the input circuit of the electrical circuit, the input and output circuits of said tube being inductively coupled in such manner that as the plate current increases the bias on the grid of said tube increases in the positive sense and as the plate current decreases such bias increases in the negative sense, and an electrical network connected in the output circuit of said tube and comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears.

3. In an electrical circuit for developing an electrical wave comprising a saw-tooth component and an impulse component, an electron tube having its input circuit excited from its output circuit in such manner that as the plate current increases the bias on the grid of said tube increases in the positive sense and as the plate current decreases such bias increases in the negative sense, a condenser connected in the grid circuit of said tube for applying to the grid a potential more negative than that required for cut-off, a resistance connected in said grid circuit and providing a discharge path for charges stored by said condenser, means for supplying control signals to said grid circuit, and an electrical network connected in the output circuit of said tube and comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears, said electrical circuit being characterized by the fact that the respective values of said condenser and said resistance and the constants and relation of the component parts are such that said tube draws plate current only once during each complete operating period thereof and for a relatively small part of such period, and being further characterized by the fact that during the time said tube draws plate current a charge is stored by said condenser sufficient to apply said potential to said grid for cut-off.

4. In an electrical circuit for developing an electrical wave comprising a saw-tooth component and an impulse component, an electron tube having its input circuit excited from its output circuit, means for applying control signals to the input circuit of said tube, means for limiting the period during which said tube draws plate

current to a relatively small part of each complete operating period of said tube, an electrical network connected in the output circuit of said tube and comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears, and means for amplifying the electrical wave developed across said network.

5. In an electrical circuit for developing an electrical wave comprising a saw-tooth component and an impulse component, a screen-grid electron tube having its grid-cathode circuit excited from its screen-grid circuit, means for applying control signals to the grid of said tube, and means supplied from the plate circuit of said tube and comprising an electrical network comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears.

6. In an electrical circuit for developing an electrical wave comprising a saw-tooth component and an impulse component, a screen-grid electron tube having its grid-cathode circuit excited from its screen-grid circuit in such manner that as the output current of said tube increases the bias on the grid of said tube increases in the positive sense and as such current decreases the bias on said grid increases in the negative sense, a condenser connected in the grid circuit of said tube for applying to the grid a potential more negative than that required for cut-off, a resistance connected in said grid circuit and providing a discharge path for charges stored by said condenser, means for supplying control signals to said grid circuit, means supplied from the plate circuit of said tube and comprising an electrical network comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears, and means for amplifying the electrical wave developed across said network.

7. In an electrical circuit for developing in its output circuit a voltage wave comprising a saw-tooth component and an impulse component, a tube connected to operate as an oscillator, means for limiting the number of oscillations of said tube to one for each operating cycle, said last-named means comprising a condenser for storing an electrical charge during the oscillation period in each cycle and a resistance providing a discharge path for said charge during the remaining period of the cycle, and a network connected in the output circuit of said tube and comprising a condenser across which said saw-tooth component appears and a resistance across which said impulse component appears.

8. In an electrical circuit for developing in its output circuit a saw-tooth electrical wave, a tube connected to operate as an oscillator, means for limiting the number of oscillations of said tube to one for each operating cycle, said last-named means comprising a condenser for storing an electrical charge during the oscillation period in each cycle and a resistance providing a discharge path for said charge during the remaining period of the cycle, and a condenser connected in the output circuit of said tube and across which a saw-tooth voltage wave appears.

WILLIAM A. TOLSON.