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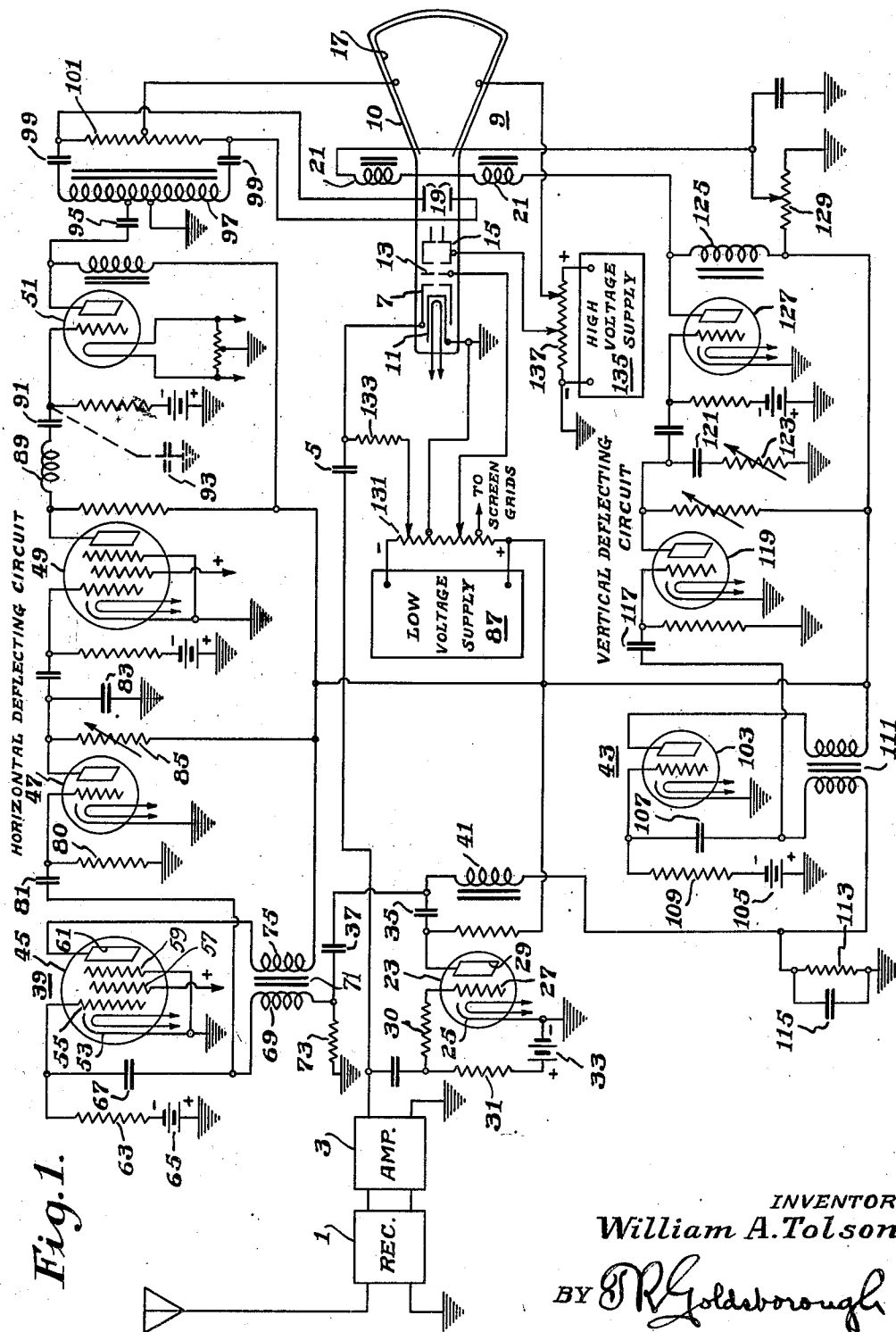
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2,108,152

ELECTRICAL CONTROL APPARATUS

Filed June 26, 1934

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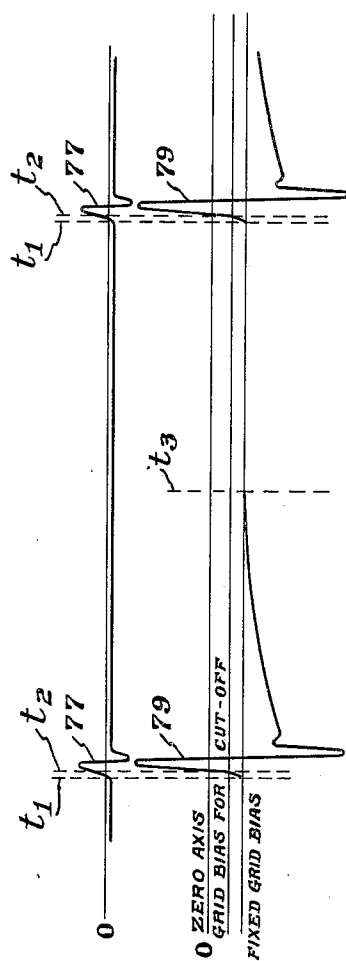
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Fig. 2.



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ELECTRICAL CONTROL APPARATUS

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Application June 26, 1934, Serial No. 732,415

4 Claims. (Cl. 250—36)

My invention relates to electrical control apparatus and more particularly to methods of and means for maintaining synchronous operation in television systems and the like.

5 In television systems utilizing a cathode-ray receiver tube it is the general practice to synchronize the scanning at the transmitter with the scanning at the receiver by transmitting a horizontal synchronizing impulse at the end of each scanning line and a vertical synchronizing or framing impulse at the end of each picture frame. At the receiver, the synchronizing impulses are separated from the picture signals and impressed upon deflecting circuits which supply the desired saw-tooth voltage or current waves to the deflecting devices of the cathode-ray tube.

10 In order that the two groups of synchronizing impulses shall control the proper deflecting circuit, they are separated from each other at the receiver by means of filter circuits. To facilitate this separation of synchronizing impulses it has been found desirable to give the horizontal synchronizing impulses a different wave shape than the framing impulses, as disclosed in application Serial No. 565,953, filed September 30, 1931, in the name of R. D. Kell, and assigned to the same assignee as this application.

15 In systems of the above described type, it has been the general practice to make each deflecting circuit at the receiver a generator of saw-tooth wave impulses. Such generators include an oscillator, such as a relaxation oscillator or a dynatron, which is adjusted to oscillate at a frequency slightly lower than the frequency of the synchronizing impulses. By so adjusting the saw-tooth wave generator, the synchronizing impulses hold the generator in step therewith whereby the scanning at the receiver is synchronous with that at the transmitter.

20 The use of saw-tooth wave generators which oscillate to produce deflecting waves whether synchronizing signals are being received or not has been fairly satisfactory, but such circuits involve the disadvantage that the oscillator of the generator must be adjusted to oscillate at approximately the frequency of the synchronizing impulses.

25 An object of my invention is to provide an improved deflecting circuit for television receivers which does not have the above mentioned disadvantage.

30 More specifically, an object of my invention is to provide a deflecting circuit which supplies saw-tooth waves of voltage or current which are com-

pletely under the control of the received synchronizing impulses.

35 A further object of my invention is to provide a deflecting circuit which is completely under the control of the received synchronizing impulses but which is more responsive to the synchronizing impulses than to noise signals.

40 In practicing my invention the horizontal and vertical synchronizing signals are transmitted on the same carrier wave as described in the above-identified Kell application. At the receiver, the synchronizing signals are impressed upon deflecting circuits which produce a saw-tooth voltage or current wave only in response to the reception of a synchronizing signal.

45 In order to make the deflecting circuits at the receiver more sensitive to synchronizing impulses than to noise signals, I preferably include in each deflecting circuit an impulse amplifier comprising a blocking oscillator circuit, the oscillator tube being so biased that it will oscillate through only one oscillating cycle in response to the reception of a synchronizing impulse. The resulting impulse appearing in the output circuit of the impulse amplifier is then impressed upon the wave-shaping portion of the deflecting circuit. Since the impulse amplifier or "blocking oscillator" cannot oscillate of its own accord, it is not "pulled into step" with the synchronizing impulses but, instead, it is directly driven by them.

50 Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawings, in which

55 Figure 1 is a circuit diagram of a preferred embodiment of my invention, and

Fig. 2 is a set of curves which are referred to in explaining the operation of the circuit shown in Fig. 1.

60 Referring to Fig. 1, a preferred embodiment of my invention includes a radio receiver 1 in which the transmitted carrier wave is demodulated to obtain the picture signals and the horizontal and vertical synchronizing impulses. The picture signals and the synchronizing impulses are amplified in an amplifier 3 and impressed through a coupling condenser 5 upon the control grid 7 of a cathode-ray receiver tube 9.

65 The receiver tube 9 comprises an evacuated envelope 10 having an electron gun therein consisting of a cathode 11, a screen grid 13 and a first anode 15. A second anode 17, which consists of a metallic coating upon the inner surface of the envelope 10, is provided to accelerate the electrons projected from the electron gun and

to aid in focusing them to the desired small point on a fluorescent screen at the end of the tube.

For obtaining horizontal deflection of the electron beam, electrostatic deflecting plates 19 are mounted inside the envelope 10. The vertical deflection of the electron beam is obtained by means of external deflecting coils 21.

The signal output of the amplifier 3 is impressed upon the input circuit of an electric discharge tube 23 which serves to separate the synchronizing impulses from the picture signals. The tube 23 includes a cathode 25, a control grid 27 and a plate 29. The grid 27 is connected to the cathode 25 through resistors 30 and 31 and through a biasing battery 33 which supplies a small positive voltage to the control grid.

The synchronizing impulses are separated from the picture signals because of the fact that, having been transmitted in the manner described in the above-mentioned Kell application, they are more negative than the picture signals when applied to the control grid of the separating tube 23. In the output circuit of the separating tube 23, the horizontal synchronizing impulses are supplied through a condenser 35 and through a coupling condenser 37 to a blocking oscillator 39 in the horizontal deflecting circuit. The vertical synchronizing impulses are supplied through the condenser 35 and through an inductance coil 41 to a blocking oscillator 43 in the vertical deflecting circuit. This separating circuit is described and claimed in my copending application Serial No. 717,715, filed March 28, 1934, and assigned to the same assignee as this application.

Referring to the horizontal deflecting circuit, it includes a blocking oscillator or driver tube 45, an impulse tube 47, an amplifier tube 49 and a power output tube 51. The blocking oscillator tube 45 may be of the screen grid type including a cathode 53, a control grid 55, a screen grid 57, a suppressor grid 59 and an anode 61. The control grid 55 is connected through a grid leak resistor 63 and through a biasing battery 65 to ground and through ground to the cathode 53. The grid circuit of the oscillator 39 also includes a grid condenser 67, the secondary 69 of a transformer 71 and a coupling resistor 73, the grid condenser, secondary and resistor being connected in series.

The anode 61 is connected through the primary 75 of the transformer 71 to a suitable source of positive potential. The screen grid 57 is supplied with positive potential in accordance with ordinary practice, while the suppressor grid 59 is connected to the cathode 53.

The bias voltage applied to the control grid 55 by the biasing battery 65 is such that the oscillator 39 will not oscillate unless a voltage impulse is applied to the circuit from an external source and, when such an impulse is applied to the circuit, will oscillate through only one cycle and then stop. In the usual sense, therefore, the device 39 is not an oscillator since it will not oscillate continuously of its own accord. However, for lack of a more descriptive term, it will be referred to in the specification and claims as a blocking oscillator.

The action of the blocking oscillator is substantially as follows:

Assuming that potential has just been applied to the anode 61, the plate current begins to increase thus inducing a voltage through the transformer 71 into the grid circuit. The coupling between the plate and grid circuits is such that,

as the plate current increases, the control grid 55 is made more positive. The resulting positive potential on the control grid 55 causes a flow of grid current which charges the grid condenser 67 in a direction such that it tends to make the control grid 55 negative.

As the plate current reaches a maximum and approaches its saturation value, its rate of increase becomes less thus inducing less positive voltage on the control grid whereby the plate current is caused to decrease in value. This reverses the direction of the induced voltage in the grid circuit whereby the control grid 55 is made so negative that the tube is biased beyond cut-off.

During the flow of grid current, the grid condenser 67 has been charged sufficiently to hold the tube 45 biased beyond the cut-off point in the absence of any other voltage in the grid circuit. Therefore, until the charge has leaked off the condenser 67 through the grid leak resistor 63, the control grid 55 has a high negative bias thereon. Because of the biasing battery 65, however, even after the charge has leaked off the grid condenser 67, the tube is still biased beyond cut-off and the blocking oscillator will remain inactive until a voltage impulse from an external source causes the above described cycle of operation to start again. In the circuit illustrated, this external voltage impulse is the horizontal synchronizing impulse, and it is applied to the oscillator circuit through the coupling resistor 73.

The operation of the blocking oscillator as a driver tube will be more clearly understood by referring to Fig. 2, which indicates wave shape and phase relation but not relative magnitude. In this figure, the horizontal synchronizing impulse which appears across the coupling resistor 73 is represented by the curve 77, while the resulting voltage appearing in the grid circuit of the blocking oscillator 39 is represented by the curve 79. Attention is called to the fact that the voltage in the grid circuit is in the form of a highly damped oscillation.

Referring to the curves, it will be seen that at the time t_1 the voltage on the control grid 55 of the driver tube 45 is that supplied by the fixed bias battery 65 and is below the cut-off point of the driver tube. At the time t_2 , the grid potential of the driver tube 45 has been raised by the incoming synchronizing impulse to the cut-off point, at which point plate current begins to flow and the cycle of operation is begun as shown. This cycle of operation is a typical blocking oscillator cycle such as described above, except that at the time t_3 , when the charge has leaked off the grid condenser 67, the cycle does not repeat but, instead, the circuit is maintained in an inactive or static condition because of the fixed bias on the control grid 55. The time from t_2 to t_3 may be referred to as the "active period" of the oscillator. The cycle of operation is not repeated again until the next horizontal synchronizing impulse occurs.

Attention also is called to the fact that the driver tube 45 is so adjusted that, with the fixed grid bias removed, it will oscillate to produce positive voltage peaks which have a smaller time interval between them than do the synchronizing impulses. That is, the interval between t_2 and t_3 (Fig. 2) is less than the interval between the horizontal synchronizing impulses 79. The reason for this adjustment is that it permits all the charge to leak off the grid condenser 67 and so return the driver tube 45 to its original state be-

fore the next synchronizing impulse occurs. This prevents the action of the driver tube, during the reception of one synchronizing impulse, from being influenced by a preceding synchronizing impulse.

It is evident from an inspection of Fig. 2 that so long as the charge is leaking off the grid condenser 67, noise signals must have an amplitude great enough to overcome the negative bias applied by the condenser 67 before they can cause the driver tube to produce a synchronizing impulse in its grid circuit. For this reason, my improved deflecting circuit is comparatively insensitive to noise signals during the greater part of the interval between synchronizing impulses.

A further advantage in the use of the driver tube 45 is that its output is substantially independent of variations in the amplitude of incoming synchronizing impulses. Also, the tube 20 45 is a very efficient amplifier of the incoming impulses.

From the above description it will be understood that a positive voltage impulse appears in the grid circuit of the driver tube 45 as a horizontal synchronizing impulse each time a horizontal synchronizing impulse is received by the radio receiver 1. If no synchronizing signals are being received, the entire deflecting circuit including the oscillator is in an inactive or static condition.

The above-mentioned positive impulses are impressed upon the impulse tube 47 through a coupling condenser 81 for producing a saw-tooth voltage wave. The circuit for producing such a voltage wave includes a condenser 83 in the plate circuit of the impulse tube 47 so connected that it is charged through a variable plate resistor 85 by energy supplied by a direct current supply 87. Each time a positive impulse is impressed upon the grid of the impulse tube 47, the condenser 40 83 is discharged through the plate circuit of the impulse tube. The resulting saw-tooth voltage wave is amplified by the amplifier tube 49 and impressed upon the input circuit of the power tube 51 through a coupling circuit which includes 45 an inductance coil 89 and a blocking condenser 91.

The inductance coil 89 is of such value that it resonates with the grid-cathode capacity of the power tube 51 at the high frequency end of the band of frequencies to be amplified. In some 50 cases, additional capacity should be connected between the grid of the tube 51 and ground, as indicated at 93, in order to obtain resonance at the desired frequency. The tuned coupling circuit performs two functions, one being to increase the 55 response of the amplifier at the higher frequencies and the other being to cut off the highest frequencies for a purpose which will be described later.

The amplified saw-tooth voltage wave is impressed through a coupling condenser 95 upon the 60 primary of an auto-transformer 97. This voltage wave appears at a much higher voltage across the terminals of the transformer secondary and is impressed upon the deflecting plates 19 through 65 blocking condensers 99.

In order to prevent defocusing of the cathode beam during deflection, it is desirable to vary the voltage on the deflecting plates 19 about the second anode potential. This result is obtained by 70 connecting a high resistance potentiometer 101 across the deflecting plates 19 and by connecting the second anode 17 to the mid-point of the potentiometer.

It was found that the leakage inductance of the 75 transformer 97 resonated with its distributed

capacity at a high frequency and that this resonance of the transformer introduced undesirable transients into the deflecting circuit. This difficulty was overcome by making the leakage inductance a minimum whereby the resonant frequency was made higher than any frequency that 5 must be transmitted to obtain a good saw-tooth voltage wave. Shock excitation of the transformer resonant circuit was then prevented by cutting off the high frequency components of the 10 deflecting wave at a frequency below the resonant point of the transformer, this being accomplished by the above-described tuned coupling circuit.

Referring now to the vertical deflecting circuit, it includes the blocking oscillator 43 15 comprising a vacuum tube 103 which is biased by means of a biasing battery 105 beyond the cut-off point, the same as the oscillator tube 45 in the horizontal deflecting circuit. The tube 103 has 20 been illustrated as a three-element tube, but it should be understood that various types of tubes may be employed either in the horizontal blocking oscillator or in the vertical blocking oscillator. The oscillator 43 includes a grid condenser 25 107, a grid leak resistor 109 and a feed-back transformer 111, all of which perform the functions described in connection with the horizontal blocking oscillator 39.

The vertical synchronizing impulses are im- 30 pressed upon the grid circuit of the oscillator 43 through a coupling resistor 113 which is included in the grid circuit in series with the secondary of the transformer 111. Preferably, the resistor 113 is shunted by a condenser 115 for by-passing 35 any horizontal synchronizing impulse component which may not be filtered out by the inductance coil 41.

The positive voltage impulses which appear in the grid circuit of the driver tube 103 in response 40 to the reception of vertical synchronizing impulses are impressed through a coupling condenser 117 upon an impulse tube 119. The output circuit of the impulse tube 119 includes a condenser 121 having a variable resistor 123 con- 45 nected in series therewith for supplying a voltage impulse wave containing a saw-tooth component. This voltage wave appears across the inductance coil 125 in the plate circuit of a power tube 127 and is impressed across the deflecting coils 21 to 50 produce a saw-tooth wave of current there-through. The resistor 129, to which one terminal of the deflecting coils is connected, is provided for the purpose of adjusting the direct current component through the deflecting coils to center the 55 electron beam on the fluorescent screen.

Referring now to the voltage supplies for the deflecting circuits and for the cathode-ray tube, all the voltages for the tubes are supplied from the low voltage supply 87 across which a voltage 60 divider 131 is connected. All the plates of the vacuum tubes are connected to the positive terminal of the voltage divider 131. The screen grids of the screen grid tubes are connected to a point of lower potential on the voltage divider 131 65 as indicated. The screen grid 13 of the cathode-ray tube is connected to a point of still lower potential on the voltage divider 131.

The cathode 11 of the cathode-ray tube is con- 70 nected to a point on the voltage divider 131 near its negative end and grounded, while the control electrode 7 of the cathode-ray tube is connected to the negative end of the voltage divider 131 through a resistor 133 for maintaining it at the 75

proper negative potential with respect to the cathode 11.

The higher voltages for the anodes of the cathode-ray tube are provided by a high voltage supply 135 having a voltage divider 137 connected thereacross. The negative end of the voltage divider 137 is connected through ground to the cathode 11 of the cathode-ray tube. The second anode 17 is connected to the positive end of the voltage divider 137, while the first anode 15 is connected to a point of lower potential on said voltage divider.

If the blocking oscillator or driver tubes 45 and 103 are omitted from the deflecting circuits and amplifiers substituted therefor the system, though entirely operative, is shorn of certain advantages. By impressing the synchronizing impulses directly, or through amplifiers, upon the impulse tubes 47 and 119, the deflecting circuits will be somewhat more sensitive to noise signals which is objectionable providing the ratio of synchronizing voltage to noise voltage is not high.

In either embodiment of my invention, the impulse tubes 47 and 119 are preferably biased close to or beyond cut-off. They may be biased beyond cut-off by inserting a biasing battery (not shown) in the grid circuit. In the particular circuit illustrated, which is the preferred one, the tubes 47 and 119 are biased close to cut-off by means of the flow of grid current in the coupling condenser-grid resistor combination.

Referring to the tube 47 as an example, a positive voltage impulse from the blocking oscillator 39 causes a flow of grid current to charge the condenser 81. Between positive voltage impulses, the condenser discharges through the grid resistor 80 to maintain the grid of the tube negatively biased. If the blocking oscillator is replaced by an amplifier (two resistance coupled vacuum tubes, for example) the biasing circuit shown is especially desirable as the bias on the impulse tube increases with increase in signal strength whereby an automatic volume action is obtained.

Whether the deflecting circuits are used with or without the driver tubes, the action of a deflecting circuit is to reshape a synchronizing impulse of the character generated in a transmitter such as described in the above-mentioned Kell application into either a saw-tooth voltage wave or a saw-tooth current wave for deflecting an electron beam. The advantage of such a directly driven deflecting circuit is that there is no possibility of the scanning at the television receiver getting out of synchronism with the scanning at the television transmitter.

The portion of the circuit comprising the tuned coupling circuit for the power tube 51, the transformer 97, the potentiometer 101 and the rest of the electrostatic deflecting circuit is described and claimed in my copending application Serial No. 737,163, filed July 27, 1934, and assigned to the same assignee as this application.

From the foregoing description it will be understood that various modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that

only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. In combination, a generator of electrical impulses comprising an electric discharge tube having a control grid and having plate and grid circuits coupled to make said tube tend to oscillate, means for applying a biasing potential to said grid such that said generator can oscillate to produce an electrical impulse only in response to receiving a potential on said grid from a source external to said oscillator, and a non-oscillatory generator of electrical impulses having a saw-tooth wave shape, said first generator being coupled directly to said second generator.

2. In combination, an amplifier tube having an input circuit and an output circuit, a series circuit including a condenser and a resistor connected in series, means for charging said condenser through said resistor, means for applying voltage from said series circuit to said input circuit, an electric discharge tube having principal electrodes and a control electrode, said principal electrodes being connected across said condenser, means including an electric discharge tube which is normally biased beyond cut-off for generating a highly damped oscillation in response to, and only in response to, the reception of a voltage impulse and means for impressing at least a portion of said damped oscillation upon said control electrode.

3. In combination, non-oscillatory means for producing an electrical impulse having a saw-tooth wave shape in response to the reception of a voltage pulse of predetermined magnitude, a blocking oscillator comprising an electric discharge tube biased beyond cut-off whereby an oscillation of short duration is produced each time a voltage impulse is impressed thereon, and means for applying at least a portion of said oscillation to said first means.

4. In combination, means for producing electrical impulses having a saw-tooth wave shape in response to the reception of voltage pulses of predetermined magnitude, said means being characterized in that it is not self-oscillatory, a blocking oscillator comprising an electric discharge tube having a control grid and having input and output circuits so inductively coupled that the tube tends to oscillate, said input circuit including a grid condenser and a grid leak resistor, said input and output circuits having such damping and said grid condenser and grid resistor having such values that in the absence of a fixed bias on said control grid the oscillator repeats a cycle of operation, each cycle consisting of a damped sine wave and a period of rest and having a duration less than the interval between said voltage pulses, means for applying a fixed bias to said grid such that said tube is biased beyond cut-off whereby it can oscillate only upon the reception of one of said voltage impulses, and means for impressing at least a portion of said damped sine wave upon said first means.

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