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SAWTOOTH WAVE GENERATOR

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*Fig. 1*

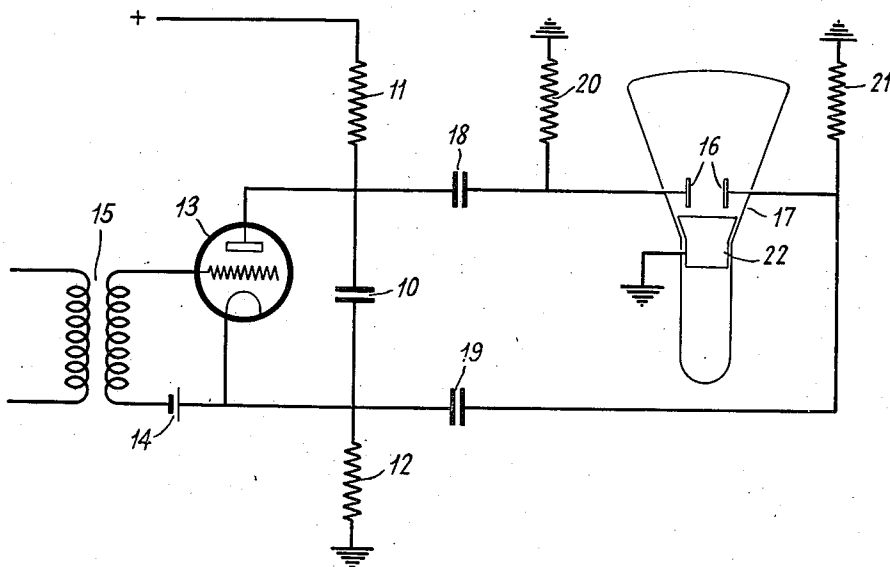
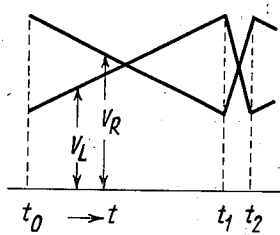
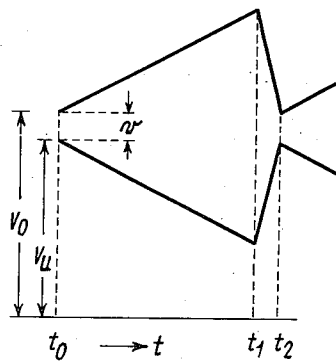


*Fig. 3*

*Fig. 2*



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## UNITED STATES PATENT OFFICE

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## SAWTOOTH WAVE GENERATOR

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5 Claims. (Cl. 250—36)

My invention relates broadly to oscillation generators and more particularly to an arrangement for producing symmetrical sawtooth potentials.

Sawtooth potentials presenting a symmetric form are required for a good many practical purposes, especially for the electrostatic deflection of cathode-ray pencils of the kind used, for instance, for the production of time base deflection in oscillographs of the Braun type and also for the production of the two picture co-ordinate deflections in television work when a cathode-ray tube is used at the sending or at the receiving end. What is here meant by a symmetric sawtooth voltage is a potential in which in the course of each of the sawtooth flanks or slopes the two terminals where the sawtooth potential is to be made available experience potential changes in opposition. A symmetric sawtooth potential is advantageous for the reason that the cathode-ray tube may be built in such a way that the axis of the cathode-ray pencil generating means or system (axis of cathode and anode) passes through the center of the fluorescent screen or other surface or area to be impinged by the cathode-ray beam, which, in turn, makes for the simplest form of glass bulb.

A solution of the problem of generating a symmetric sawtooth potential has been attempted in that first a dissymmetric potential was generated, whereupon, by the use of a push-pull amplifier stage, the symmetric sawtooth potential was obtained. However, such a circuit arrangement is rather complicated for it comprises a total of three discharge vessels if it is to give satisfaction in practice.

Now, with a view to generating a symmetric sawtooth potential a circuit arrangement is used according to this invention which has the feature that a condenser is connected by way of two resistances of similar size with the two poles of a source of D. C., while in parallel relationship to the condenser is connected the filament-plate path of a grid-controlled discharge tube, brief voltage impulses of the frequency of the desired sawtooth potential being applied to the control grid of the said tube.

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

Fig. 1 is an embodiment of my invention,

Figs. 2 and 3 are explanatory curves.

Referring to Fig. 1, 10 denotes a condenser which by way of two resistances 11 and 12 is united with the positive and the negative grounded pole of a source of D. C. voltage. In parallel relationship to the condenser 10 is the

filament plate path of a grid controlled discharge tube 13 whose control grid circuit contains a negative grid biasing voltage source 14 as well as the secondary winding of a 1:1 transformer 15.

Further, in parallel relation to the condenser 10 is a branch circuit which contains the deflector plates 16 of a Braun tube 17 as well as two blocking condensers 18, 19. The two deflection plates 16 are grounded by way of two resistances 20, 21; also the second anode or gun 22 of the Braun tube is earthed.

The arrangement illustrated in Fig. 1 operates in the following manner. As long as the tube 13 is blocked, the upper or the lower coat of the condenser 10 approaches the potential of the positive or the negative pole of the D. C. voltage source. This is illustrated in Fig. 2. Suppose that at time  $t_0$  the two coats are at the potentials  $V_0$  and  $V_u$ , the latter differing by  $v$ . From the source of D. C. potential there will then flow by way of the two resistances 11 and 12 a charge current to the condenser which, during the incipient part of the charge process may be regarded as presenting time constancy. Hence, the potentials of the two condenser coats are subject to linear variation with time in this sense that the potential of the upper coat tends towards the potential of the positive pole and the lower coat that of the negative pole of the D. C. source of potential. At the instant  $t_1$  the tube is rendered conducting for current and as a result the condenser 10 will be charged up, that is, it shall be assumed to be charged to a voltage  $v$ . Next, at instant  $t_2$ , the tube will be wiped out or blocked again, and the process before described is repeated. The D. C. voltage component of the sawtooth potential arising at the condenser 10 is taken by the blocking condensers 18, 19, so that what appears and acts at the deflection plates 16 of the Braun tube is a sawtooth voltage which presents a perfectly symmetric shape. The time constant of the capacity of the two deflector plates 16 in reference to each other and the resistances 20, 21 is high in contrast to the desired sawtooth frequency. The potentials of the two deflection plates therefore, change, as illustrated in Fig. 2,  $V_L$  showing the shape of potential of the left-hand deflection plate, and  $V_R$  that of the right-hand deflection plate. In other words, the deflection field intensity changes inside time  $t_0, t_1$  from a negative crest value through zero to a positive maximum, while inside the period  $t_1, t_2$  it experiences the same change in the contrary sense.

The opening or unblocking of tube 13, Fig. 1,

is accomplished by brief potential pulses which always are initiated at instant  $t_1$  and which should not last beyond instant  $t_2$ . Hence, these impulses must arise at the control grid of tube 13 at the frequency of the desired sawtooth potential.

It is preferable that tube 13 should be of the high vacuum type. For this offers the advantage that, with a prearranged voltage of the source of D. C. potential (for which may be used a D. C. existing anyway in the television transmitter or receiver) and for given values of the resistances 11, 12 as well as condenser 10 (the choice of which, for other reasons, is subject to certain limitations), the amplitude of the sawtooth voltage may be adjusted.

Particularly suited will be a high-vacuum tube 13 when connected in the so-called blocking oscillator circuit scheme. This is a regenerative oscillator tube in which the coupling is very strong, and whose plate circuit carries only brief current impulses which wax and wane very steeply. Such a blocking oscillator fulfills the double purpose (1) that such voltage impulses which may not always arise at its control grid with perfectly identical amplitude will be converted in plate current impulses being always of exactly the same shape; and (2) that it insures at the same time an amplification of the voltage impulses. In a circuit organization of the kind here disclosed the use of a high-vacuum tube in a blocking oscillator circuit scheme is particularly suited also for this reason that it does not require any distinct grid biasing voltage source 14, for the grid bias voltage is obtained by means of inductive coupling of the grid and the plate circuit. This is a particularly important fact so far as the circuit organization of this invention is concerned seeing that the cathode of tube 13 is not operated at a fixed potential, so that, for the separate production of the grid biasing voltage, a distinct small-sized power pack to be connected with a supply line would be required.

What I claim is:

1. A sawtooth wave generator comprising a condenser, a pair of resistances of substantially the same value connected in series with said condenser, one of said resistances being joined to one terminal of said condenser and the other of said resistances being joined to the other terminal of said condenser, a source of electrical energy electrically connected to said resistors, one pole of said source being electrically connected to one of said resistors, and the other pole thereof being connected to the other of said resistors, said resistors, said condenser, and said source being included in a closed series circuit, and a discharge path connected in parallel to said condenser.

2. A sawtooth wave generator comprising a condenser, a pair of resistances of substantially the same value connected in series with said con-

denser, one of said resistances being joined to one terminal of said condenser and the other of said resistances being joined to the other terminal of said condenser, a source of electrical energy electrically connected to said resistors, one pole of said source being electrically connected to one of said resistors, and the other pole thereof being connected to the other of said resistors, said resistors, said condenser, and said source being included in a closed series circuit, and a discharge path comprising a thermionic tube connected in parallel to said condenser, the anode of said tube being connected directly to one terminal of said condenser, and the cathode thereof being connected to the other terminal of said condenser.

3. A sawtooth wave generator comprising electrical storage means, a pair of resistance members of substantially equal values electrically connected to said storage means, a source of direct electrical energy having one pole thereof electrically connected to one of said resistance members, and the other pole thereof electrically connected to the other of said resistance members, said resistances, said condenser, and said source being included in a closed series circuit, a discharge path comprising a normally blocked thermionic tube connected in parallel with said electrical storage means, the anode of said tube being connected directly to one terminal of said condenser, and the cathode thereof being connected to the other terminal of said condenser, and means for rendering said tube conducting at intervals.

4. A sawtooth wave generator comprising a condenser having two terminals, a first resistor having one terminal thereof connected directly to one terminal of the condenser, a second resistor having one terminal connected to the other terminal of said condenser and the other terminal of the resistance directly connected to a point of fixed reference potential, a direct current source of energy having the positive pole thereof connected directly to the terminal of the first resistor remote from the terminal of the resistor connected to the condenser and having the negative pole thereof connected directly to the point of fixed reference potential, a thermionic tube having anode, cathode and at least one control electrode, the anode of said tube being connected directly to one terminal of the condenser and the cathode of said tube being connected directly to the other terminal of the condenser, means for receiving intermittent signals from a source external to said generator, and means for maintaining said thermionic tube conducting while a signal from said external source is being received and blocked during the intervals between receipt of said signals from said external source.

5. Apparatus in accordance with claim 4, wherein said resistor and said second resistor are substantially equal in value.

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