

Oct. 26, 1937.

M. BOWMAN-MANIFOLD

2,097,334

CONTROL CIRCUITS FOR CATHODE RAY DEVICES

Filed May 13, 1933

2 Sheets-Sheet 1

Fig. 1

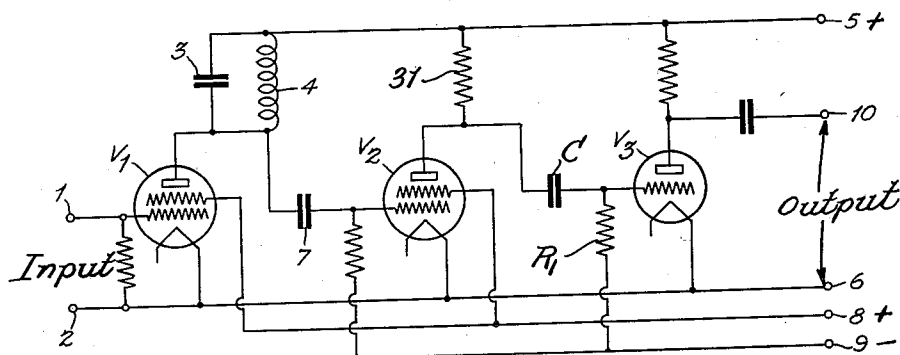


Fig. 2

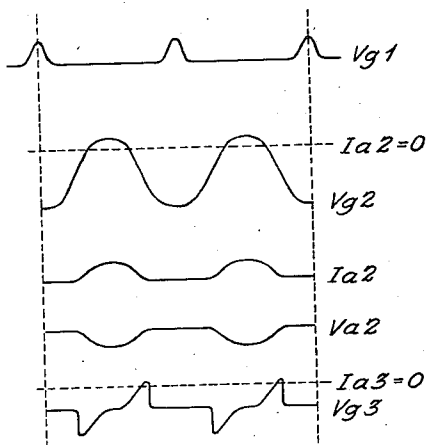
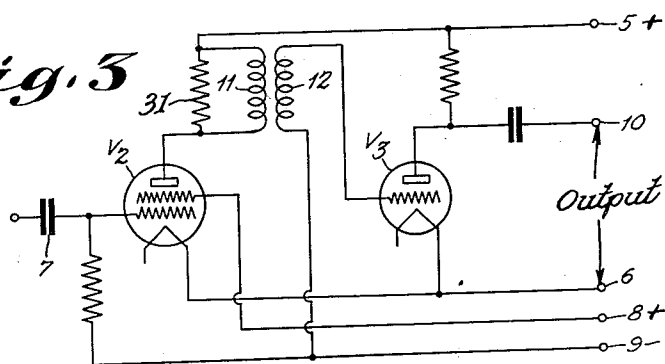


Fig. 3



INVENTOR
M. BOWMAN-MANIFOLD
BY *W. S. Sawyer*
ATTORNEY

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M. BOWMAN-MANIFOLD

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2 Sheets-Sheet 2

Fig. 4

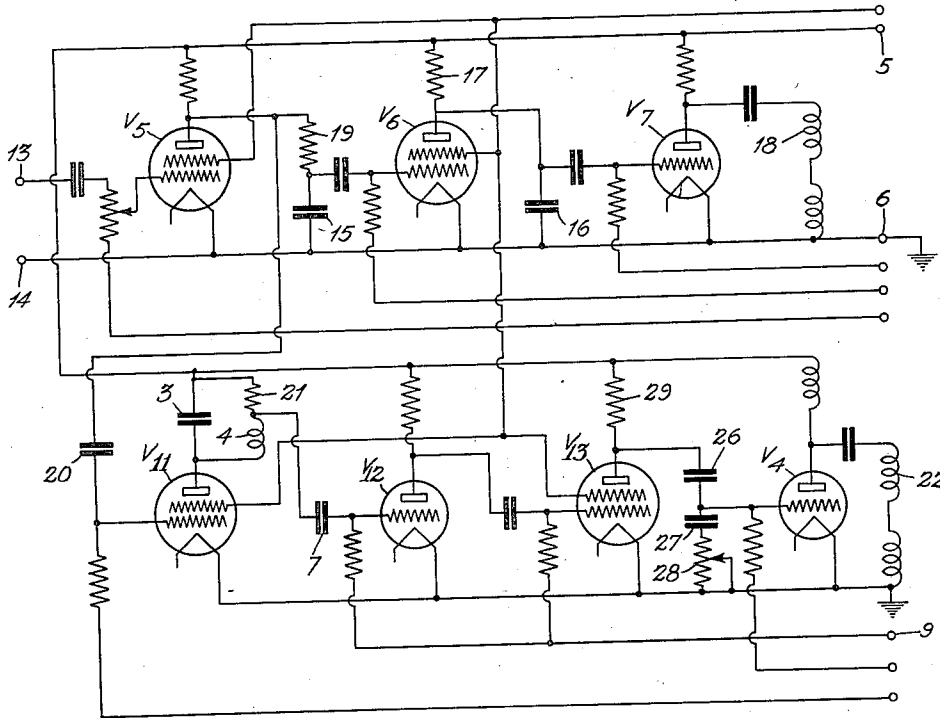
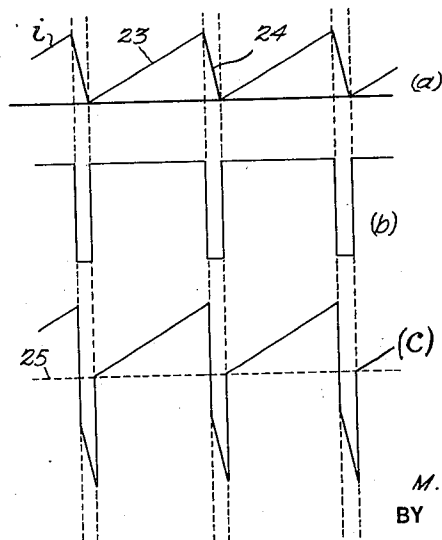


Fig. 5



INVENTOR
M. BOWMAN-MANIFOLD
BY *J. S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

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CONTROL CIRCUITS FOR CATHODE RAY
DEVICES

Michael Bowman-Manifold, Heathcot, England,
assignor to Electric & Musical Industries, Ltd.,
a corporation of Great Britain

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In Great Britain May 26, 1932

5 Claims. (Cl. 250—36)

The present invention relates to electrical circuits such as may be used, for example, as time bases in connection with cathode ray devices, for the purpose of producing periodic deflection of the ray.

The invention is mainly concerned with the generation of non-sinusoidal oscillations adapted to produce deflection of the cathode ray and of the kind in which each cycle of deflection comprises a relatively slow motion in one direction followed by a relatively rapid motion in the opposite direction. Arrangements of this kind are, for example, used in television systems; when used at the receiver, reconstitution of a line of the transmitted image occurs during the slow motion of the ray and the rapid motion constitutes the return stroke which is necessary before the next line of the image can be reconstituted. The requirements of such arrangements are, amongst other things, that the slow motion shall be uniform and that the duration of the return stroke shall be as small as possible. The wave form of the motion of the ray during the return stroke is, however, unimportant.

It is known that a cathode ray may be deflected in the manner described above either electrostatically or electromagnetically; for the electrostatic deflection of the ray there is applied to a pair of deflecting plates of the tube a varying potential difference of saw tooth wave form, and for the electromagnetic deflection of the ray a current of saw tooth wave form is passed through a pair of deflecting coils associated with the tube.

Since it is desirable that the return stroke of the cathode ray should be effected as quickly as possible, the voltage or current decay should be of extremely short duration compared to the duration of voltage or current growth, and it is an object of the present invention to provide means for generating a voltage or current wave of saw tooth shape in which the ratio of the durations of decay and growth for each cycle is extremely small.

According to the present invention a device is provided for generating electrical impulses of durations which are much shorter than the intervals between them, means being provided for controlling the frequency of the impulses in accordance with oscillations of sinusoidal wave form. Since the frequency of sinusoidal oscillations can be kept very constant, the frequency of the impulses will likewise be very constant and, moreover, as the duration of the impulses is made very short relatively to the interval between them, the duration of the return stroke of the

cathode ray, which cannot normally be less than that of the impulse, can also be made very short.

The impulses may be used in known manner to control the apparatus designed to generate voltage oscillations of saw-tooth wave form. Such voltage oscillations can be applied directly to the deflecting plates of a cathode ray device. Where, however, it is desired to deflect the ray electromagnetically, such saw-tooth voltages cannot be used directly since in an inductance they produce currents having an incorrect wave form. A suitable voltage wave form is the sum of two factors, one of saw-tooth wave form and the other proportional to its first differential.

According to a feature of the present invention, therefore, there is provided apparatus for generating in an inductance, for example the control coil of a cathode ray device, a current of saw tooth wave form from electrical impulses of durations which are much shorter than the intervals between them, comprising a thermionic valve having in parallel with its anode circuit two condensers and a resistance, all arranged in series, means for applying said impulses to the control grid circuit of said valve and means for applying to said coil potentials developed across said resistance and one of said condensers.

The invention will be described with reference to the accompanying drawings in which:

Fig. 1 is a diagram of a circuit in accordance with the invention;

Fig. 2 contains a series of curves illustrating the invention;

Fig. 3 shows a modification of the circuit of Fig. 1;

Fig. 4 is a further circuit diagram according to the invention; and

Fig. 5 contains a second series of curves illustrating a feature of the invention.

Like references are used to indicate like parts in the various figures of the drawings.

For the purpose of preliminary explanation of the invention, it will be assumed that it is desired to scan a fluorescent screen, situated at one end of a cathode ray tube, in close parallel lines. For this purpose two saw tooth voltage waves are applied to two pairs of plates associated with the tube. Each of the voltage waves is obtained from the plates of a condenser which is alternately charged uniformly and discharged, the discharge occurring through a thermionic valve or other suitable form of discharge device. This part of the arrangement is quite well known and the present invention is concerned more particularly with the means for

rendering the thermionic valve or other discharge device alternately conducting and non-conducting. The discharge device may for example be a three electrode thermionic valve, the conductivity of the anode-cathode path being controlled by impulses applied to its grid.

A series of current impulses of roughly constant frequency is first developed by mechanical means, for example by intercepting a beam of light of constant intensity with a rotating disc bearing concentrically arranged apertures, the light transmitted by the apertures in the disc being incident upon a photo-electric cell. Assuming that the speed of the disc is constant, the average frequency of the impulses generated in the cell will be constant although the amplitude and spacing of successive impulses may possibly vary to a slight extent due to slight variances or errors in the size and spacing of the apertures which make the disc slightly non-uniform or symmetrical throughout.

Referring now to Fig. 1, the impulses generated in the cell are applied to the input terminals 1, 2 of a four electrode valve V_1 having its anode connected through a tuned circuit 3, 4 to a point 5 of positive potential in relation to the cathode terminal 6. The anode of the valve V_1 is connected through a condenser 7 to the grid of a second four electrode valve V_2 which is resistance-capacity coupled to a third valve V_3 . The screen grids of the valves V_3 and V_2 are given a suitable positive potential from terminal 8 and the control grids of these valves are connected through grid leaks to a point 9 at a considerable negative potential relative to the cathodes. The negative bias on the control grids of valves V_2 and V_3 is considerably greater than that corresponding to substantially zero anode current flow through the valves. The output is taken from terminals 6 and 10.

The operation of the circuit of Fig. 1 will be explained with reference to Fig. 2 in which voltage or current is plotted as ordinate against time as abscissa. Curve Vg_1 shows the voltage applied to the grid of valve V_1 due to the photo-cell impulses fed to terminals 1, 2. The corresponding pulses in the anode circuit of V_1 cause sinusoidal oscillations to arise in the circuit 3, 4 and the voltage thereby developed upon the grid of valve V_2 is shown by Vg_2 . It will be noted that at the time when a positive pulse arrives at the grid of V_1 , the anode of V_1 , and therefore the grid of V_2 , is at maximum negative potential. The grid of valve V_2 is so biased that the voltage wave Vg_2 is nearly all beneath the line $Ia_2=0$ which represents the grid voltage below which substantially no anode current flows in the valve V_2 . Thus pulses of current represented by Ia_2 flow in the anode circuit of V_2 and produce voltage pulsations, represented by Va_2 , at the anode of V_2 . These voltage pulses cannot in practice be made of very short durations, for example not much less than one quarter of a period, without making their magnitudes almost imperceptible, and they are consequently not themselves suitable for initiating the discharge of a thermionic valve as above mentioned. They are therefore passed to the grid of valve V_3 through a condenser, (capacity C) which with its associated grid leak (resistance R_1) has a time constant (CR_1) appreciably shorter than the duration of the current pulse in V_2 , thereby producing on the grid voltage pulses indicated by Vg_3 . This grid of valve V_3 is biased so that substantially no anode current flows in the valve V_3 when the grid volt-

age is below the value indicated by the line $Ia_3=0$ and consequently there are generated in the anode circuit of the valve V_3 pulses of current of extremely short durations, that is to say of durations which are much shorter than the intervals between them. Because of the method by which the pulses are generated, their phase and amplitude being controlled by sinusoidal oscillations, they are very constant in amplitude, duration and spacing and can be used to control the discharge of the valve and thereby to control the generation of a saw-tooth wave.

If desired, an inductance coil, not shown, which may be assumed to have an inductance L, may be arranged in parallel with the anode resistance 31, which may be assumed to have a resistance R_2 , of the valve V_2 . The time constant

$$\left(\frac{L}{R_2}\right)$$

of such an inductance and the parallel anode resistance should be appreciably shorter than the duration of the current pulse in V_2 . In this case the time constant (CR_1) of the condenser and grid leak need not be short.

In the modification shown in Fig. 3, where only the circuits associated with valves V_2 and V_3 are indicated, the anode resistance 31 of the valve V_2 is arranged in parallel with the primary winding 11 of a transformer. The time constant of the primary winding 11 and the anode resistance 31 should be appreciably shorter than the duration of the current pulse in V_2 . The secondary winding 12 of the transformer is connected to the grid circuit of the valve V_3 .

It will be observed from Fig. 2 that the voltage pulses Vg_2 appearing on the grid of valve V_2 have a phase lag of 180° with respect to the voltage pulses Vg_1 applied to the grid of the valve V_1 . Further it is found in practice that the positive pulses Vg_3 above the line $Ia_3=0$ lag about 90° with respect to the pulses Va_2 . Thus there is an overall phase lag of resultant impulses over initiating impulses of about 270° . Where the circuit described is used at the receiver of a television system, therefore, in conjunction with a transmitter sending synchronizing impulses in the intervals between the scanning of successive lines, the saw-tooth wave generated from the impulses at the terminals 6, 10 will be in incorrect phase relation to the received picture signals. This may be corrected by delaying the resultant pulses a further 90° , making 360° in all, so that they are, in effect, in phase with the initiating pulses.

The current in the inductance 4 of Fig. 1 lags 90° with respect to the voltage at the anode of V_1 and accordingly by passing to valve V_2 a voltage proportional to the current in the inductance 4, the required phase relation can be obtained. This can be done by inserting a resistance in series with the inductance 4, the resistance and the inductance being in parallel with the condenser 3, and by passing the voltage developed across this resistance to the valve V_2 .

An example of this arrangement is shown in Fig. 4 which is a circuit diagram of the part of a receiver which handles synchronizing signals. The type of transmission with which the receiver is adapted to work is one in which a relative short pulse, known as a line impulse, is developed at the transmitter in the interval between the scanning of adjacent lines and a longer pulse, known as a framing impulse, is generated in the interval between the scanning of successive pic-

tures of a motion picture film. These impulses are each caused to produce a train of oscillations at a frequency, referred to as a sub-carrier frequency, higher than the highest frequency of importance in the picture signals, the durations of the trains being substantially equal to the durations of the corresponding impulses. These trains of sub-carrier oscillations are mixed with the picture signals and used to modulate a carrier wave.

At the receiver the carrier is detected and the composite modulation is applied to a circuit tuned to the sub-carrier frequency which passes picture signals to the control grid circuit of a cathode ray tube and selects the sub-carrier oscillations and passes them to terminals 13, 14 in Fig. 4. The valve V_5 detects the sub-carrier and the voltages fed to the valve V_6 are almost entirely the framing impulses since the higher frequency line impulses are shunted away by the condenser 15. The valve V_6 is so biased that it is normally substantially non-conducting and the condenser 16 is slowly charged through the resistance 17. When a framing impulse arrives on the grid of V_6 it becomes conducting and rapidly discharges the condenser 16. The voltage applied to the grid of the amplifier valve V_7 is thus of saw-tooth wave form. The coils 18 serving to deflect the cathode ray in a direction perpendicular to the scanning lines are connected in the output of the valve V_7 . By making the impedance of the coils 18 low in comparison with the valve V_7 at the operating frequency, the current in the coils can also be made of saw-tooth wave form.

The voltage developed across resistance 19 and condenser 15 is fed through a condenser 20 to the grid circuit of the valve V_1 , the condenser 20 serving substantially to prevent the passage of the framing impulses and allowing the line impulses to pass readily. The valves V_{11} , V_{12} and V_{13} are arranged substantially like the valves V_1 , V_2 , V_3 shown in Fig. 1 excepting that the voltage passed to the valve V_{12} is that developed across the resistance 21, for the reason above given.

The valve V_4 is an amplifier and it is usually inconvenient or impossible to make the impedance of the coils 22, which serve to deflect the cathode ray in the direction of line scanning, sufficiently low for the current developed in the coils 22 by a saw-tooth voltage wave to be of saw-tooth form.

Referring to Fig. 5, a current i of the form shown at (a) is required in the coils 22, the part 23 being the working stroke and the part 24 the return stroke. The voltage which will force such a current through the coils is given by

$$Ri + L \frac{di}{dt}$$

where R and L are the resistance and inductance of the coil respectively. The

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

portion of this voltage is of the form shown at (b) and the Ri portion will be of the same wave form as the current (a). Adding these curves (a) and (b) together we obtain curve (c) which represents the required voltage. Since the form of the return stroke 24 is of no importance, the shape of the part of the voltage wave (c) below the line 25 is of no importance. A voltage of the required form can be obtained, as shown in Fig. 4, by arranging in parallel across the

anode circuit of the valve V_3 two condensers 26 and 27 in series with a resistance 28 which may be variable. The condenser 27 is of larger capacity than the condenser 26 and the voltage across condenser 27 and resistance 28 is fed to the grid circuit of the amplifier valve V_4 having the coils 22 in its output circuit. During the instants of very short duration, when the valve V_3 is conducting, as described in connection with Figs. 1 and 2, the condensers 26 and 27 which have been charging through the resistance 29 are suddenly discharged and the voltage so developed at the grid of valve V_4 is of the required form.

Having now described the invention, what is claimed as new and desired to protect by Letters Patent is the following:

1. Apparatus for generating electrical impulses of saw-tooth wave formation from electrical impulses of durations which are substantially shorter than the time intervals between them comprising an electrical storage device, means for charging the storage device at substantially a constant rate, means for receiving and amplifying signals of two different periodicities, means for separating the signals of the two periodicities from each other, a thermionic device having its output circuit connected across said electrical storage element, means for biasing the control electrode of said thermionic device normally below cut-off and to such a value that the said device is rendered conductive upon the application of said impulses thereon so that said electrical storage element is discharged rapidly, and a second thermionic device having its input circuit connected across said electrical storage element so as to produce in its output circuit a saw-tooth formation electrical wave of predetermined characteristics and having a periodicity corresponding to that of the impulses serving to discharge said electrical storage element, and a current amplifier for amplifying said produced saw-tooth electrical wave.

2. Apparatus for generating in an inductance coil a current of saw-tooth wave formation which comprises an electron tube, a plurality of capacity and resistance elements serially connected in the output circuit of said tube, means for charging said condensers, means for controlling the current flow through said electron tube in accordance with the periodicity of supplied electrical impulses, and a second electron tube having its input circuit connected in parallel with one of said condenser and resistance elements, and an inductance coil connected in the output circuit of said second-named electron tube so that the time derivative of the current flowing through said inductance is proportional to the potentials developed across said resistor and condenser combination.

3. A system for generating impulses of predetermined character comprising means for receiving a series of impulses of electrical energy at substantially regularly spaced intervals of time, an oscillatory circuit comprising capacity and inductance elements adapted under the control of the received impulses to be set in oscillation, a thermionic relay, means to bias the relay to a predetermined operating point so as to have considerably greater bias than zero anode current, and means to apply to the control element of the relay a voltage substantially proportionate to the current in the inductive portion of the oscillatory circuit to control the output energy from the relay.

4. Apparatus for generating in an inductance

coil a current of saw-tooth wave form from electrical impulses of durations which are much shorter than the intervals between them, comprising a thermionic valve having in parallel with its anode circuit two condensers and a resistance, all arranged in series, means for applying said impulses to the control grid circuit of said valve and means for applying to said coil potentials developed across said resistance and one of said condensers.

5. A control circuit comprising a first thermionic tube adapted to have signal impulses occurring at regularly spaced intervals of time applied to the control electrode thereof, a second thermionic tube, a capacity element for connecting the second tube input with the first tube out-

put, a tuned circuit comprising inductance and capacity elements connected with the output circuit of the first tube so that the voltage applied to the control electrode of the second tube is substantially proportionate to the current in the inductive portion of the tuned circuit, a third thermionic tube capacitively connected to the output of the second tube, means for biasing the second and third tubes to a predetermined value to limit the output thereof to time periods of predetermined amplitude of applied voltage only whereby the output voltage from the third tube is a series of impulses of substantially less duration than the time intervals between them.

MICHAEL BOWMAN-MANIFOLD.