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ELECTRICAL TIME CIRCUIT ARRANGEMENT AND OSCILLATION GENERATOR

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Fig. 1

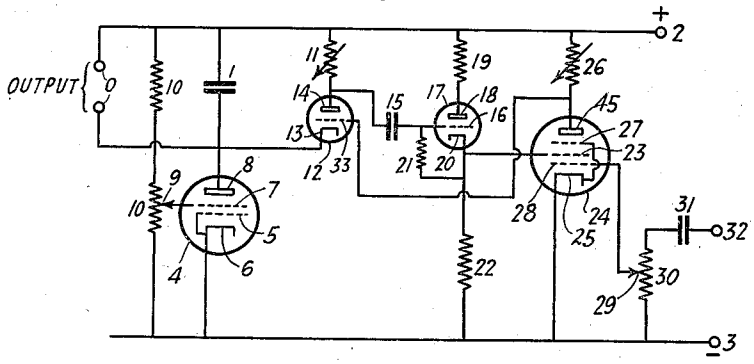


Fig. 2

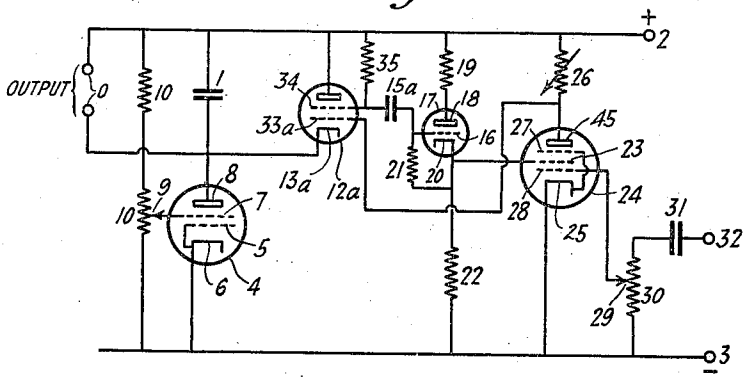
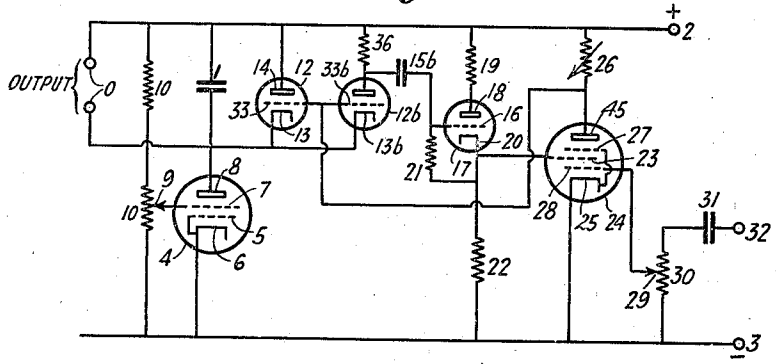


Fig. 3



INVENTOR.
ARTHUR J. YOUNG

BY H. G. Brower
ATTORNEY.

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ELECTRICAL TIME CIRCUIT ARRANGEMENT AND OSCILLATION GENERATOR

Arthur James Young, Putney, London, England, assignor to Radio Corporation of America, a corporation of Delaware

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14 Claims. (Cl. 250—36)

This invention relates to electron discharge device circuit arrangements where a high speed non-mechanical switching action is required. Though not limited to its application thereto, the primary application of the invention is to electrical time circuit arrangements and oscillation generators (suitable for use inter alia as time bases for television and other cathode ray tube apparatus) of the relaxation oscillator type; that is to say, of the type wherein the charge in a condenser is changed in one direction at a predetermined, relatively slow rate and is then changed at a relatively high rate in the other direction back to an original value, whereupon the relatively slow rate of change of charge in the first direction is repeated and so on cyclically and repeatedly so that saw tooth waves of potential or current are generated.

In such electrical time circuit arrangements for television use, it is highly desirable that the ratio of the time during which the slow change of charge occurs to the time occupied by the quick change of charge, i. e. the "sweep fly-back" time ratio, shall be as large as possible and that the smaller time shall be as nearly zero as possible. It is also highly desirable, especially for television purposes, that relatively high frequencies may be generated, i. e., that the periodicity of the time circuit arrangement may be made small and that the circuit shall be stable and not unduly critical as to its adjustment even when used for high frequencies.

The main object of the present invention as applied to time base circuits is to provide an improved electrical time circuit arrangement in which these requirements shall be satisfied.

It is known in electrical time circuit arrangements to arrange a condenser to be continuously charged at a predetermined relatively slow rate through a suitable constant current impedance device—for example, the anode-cathode space of a thermionic valve—and to arrange for this condenser to be periodically and suddenly discharged by means of a pair of thermionic valves one of which has its anode-cathode space in a circuit in shunt across the condenser and the other of which has its grid coupled to the anode of the first valve and its anode coupled back to the grid of the said first valve. It is also well known in time base circuits of the kind wherein a condenser is slowly charged and suddenly discharged (or vice versa) to produce the sudden changes in state of charge by means of a so-called "Thyratron", a form of gaseous discharge device which is widely used not only in time base circuits but also in other circuits wherein what is in effect very high speed non-mechanical switching is required.

Known electrical time base circuits as above described and also "Thyratron" switching circuit arrangements leave much to be desired—particularly from the point of view of stability—when attempts are made to use them for high frequencies; for example, great difficulty has been experienced with such known time base circuit arrangements in securing stability of operation where the frequency of the saw-tooth wave to be generated is as high as 150 kilocycles per second or thereabouts. Another difficulty with such known arrangements is that the circuit adjustments are rather critical, more particularly where high frequencies are in question. The present invention provides arrangements which can be satisfactorily employed at frequencies well above 150 kilocycles per second—in fact, in experimental use of the invention as applied to time base circuits (its principal application) no difficulty has been experienced in securing satisfactory operation at 250 kilocycles per second.

According to this invention, in an electrical time base circuit arrangement or in any other arrangement where high speed non-mechanical switching action is required, the said switching action is obtained by means including at least three valves so interconnected that at any instant one of them (to be hereinafter termed the first valve) is conductive and the other two (to be hereinafter termed the second and third valves) are non-conductive or vice versa, and the said first valve is utilized to provide by reason of its own changes of internal conductivity the periodic sudden switching changes, this valve being interconnected with the second valve in such manner that when the first valve changes from a non-conductive to a conductive state it causes the second valve to change from a conductive to a non-conductive state, said second valve being in turn connected with the third valve in such manner that when the second valve changes to a non-conductive state the third valve also changes to a non-conductive state, the said third valve being in its turn interconnected back to control the internal resistance of the first valve in such manner that when the third valve becomes non-conductive the control exercised upon the first valve is such as to increase its conductivity. Preferably the third valve is a multi-grid valve and preferably also, the invention is applied to a time base circuit in which synchronism of the oscillations

generated with incoming oscillations is required to be effected, the incoming synchronizing impulses are applied to one of the grids of the said multi-grid third valve.

The invention is illustrated in the accompanying drawing, Figs. 1 to 3 of which show diagrammatically various embodiments thereof.

Referring to Fig. 1, which shows one way of carrying out this invention, the time base circuit arrangement therein represented comprises a main condenser 1 which is charged continuously at a predetermined rate from a suitable source (not shown) of potential—e. g. a 500 volt source whose positive terminal is connected at 2 and whose negative terminal is connected at 3—through a constant current impedance constituted by the anode-cathode space of a two grid valve 4 whose innermost grid 5 is connected to the cathode 6 and whose outermost grid 7, i. e., that nearest the anode 8, is adjustably tapped at 9 upon a potentiometer resistance 10 shunted across the source of potential connected between 2 and 3, the cathode 6 being connected to the terminal 3 and the tapping 9 being selected to secure a desired predetermined rate of charge. Shunted across the main condenser 1 is a circuit consisting of a resistance 11 (of for example 10,000 ohms and which may be adjustable) in series with the anode-cathode space of a triode 12 which constitutes the first valve, the cathode 13 of the first valve 12 being connected to the anode 8 of the valve 4. The anode 14 of the valve 12 is connected through a coupling condenser 15 (of for example .01 microfarad) to the grid 16 of a second triode 17 which constitutes the second valve, the anode 18 of this second valve being connected to the positive terminal 2 through a resistance 19 of, for example 100,000 ohms. The cathode 20 of the second valve 17 is connected to the grid 16 thereof through a grid leak 21 of, say, 2 megohms and is also connected to the negative terminal 3 through a resistance 22 of, for example, 1 megohm. In some cases, where the insulation of the cathode 20 permits, the resistance 22 may be omitted. The said cathode 20 is also directly connected to the screen grid 23 (i. e. the middle grid) of a pentode 24 which constitutes the third valve. The cathode 25 of the third valve 24 is connected to the negative terminal 3 and the anode 45 of said third valve 24 is connected to the positive terminal 2 through a resistance 26 which may be adjustable and of, for example, 500,000 ohms. The outermost grid 27 of the third valve 24, i. e., that which is normally termed the "suppressor" grid, is connected to the cathode 25 and the innermost grid 28 is connected to an adjustable tapping point 29 upon a resistance 30 (of, for example, 1 megohm) which is in series with a condenser 31 (of, for example, 1 microfarad) between a pair of terminals to which incoming synchronizing impulses are applied, one of said pair of terminals being marked 32 and the other (to which one end of the 1 megohm resistance 30 is connected) being the negative terminal 3. The anode 45 of the third valve 24 is directly connected to the grid 33 of the first valve 12. Saw tooth wave output is taken off at 0 from across the main condenser 1.

The arrangement is such that during periods in which the main condenser 1 is receiving a charge the first valve 12 is non-conductive and the second and third valves 17, 24 are conductive, the first valve 12 being at such times biased to or beyond its cut-off point by means of voltage drop set up in the resistance 26. The anode current of the second valve 17 flows through the resistance 22 and also through the screen grid 23 of the third valve 24 since the cathode 20 of the second valve 17 is directly connected to this screen grid. When the main condenser 1 reaches a predetermined state of charge the first valve 12 commences to pass anode current by reason of the rise in its anode potential and this sets up a voltage drop across the resistance 11. Thus a pulse is fed through the coupling condenser 15 from the anode of the first valve 12 to the grid 16 of the second valve 17, this pulse reducing the anode current of the second valve which in turn reduces the screen grid current of the third valve 24 since the anode circuit of the second valve and the screen grid circuit of the third valve are common. This reduction in the screen grid current of the third valve causes the anode current of the said third valve to reduce, which in turn reduces the voltage drop across the resistance 26, consequently reducing the grid bias on the first valve. This sequence of operations is cumulative and therefore accelerates discharge of the main condenser until the said condenser is discharged down to a predetermined value at which the first valve again becomes non-conductive and the whole cycle commences anew.

By reason of the cumulative action, the rate of discharge of the condenser is made extremely rapid. It is found that the values of the coupling condenser 15 and resistance 11 which constitute the coupling means between the first and second valves 12 and 17 are not critical, while furthermore the succession of pulses derived from the anode of the first valve is sufficient to ensure that the grid of the second valve is held negative throughout the period of discharge. It is believed that this fact largely accounts for the improved operation obtained at high frequencies with the described circuit as compared to known circuits. Furthermore it will be noted that with the described circuit the screen grid of the pentode 24 is effectively disconnected from the source of positive operating potential by reason of the interposition of the second valve and there is no necessity for the said screen grid to be negative with respect to its associated cathode during the discharging periods of the main condenser. In fact, in the particular circuit described it does not become negative. These features are also believed to assist in securing stability at high frequencies.

In the embodiment of Fig. 1 the first valve 12, whose anode is resistance-capacity coupled to the grid of the second valve 17 has a resistance 11 in its anode circuit, this resistance being in series with the anode cathode space of the said first valve 12 across the main condenser 1. The presence of this resistance accordingly tends to increase the time taken to discharge the main condenser. In the modification shown in Fig. 2 this defect is removed by replacing the first valve 12 of Fig. 1 (which is a triode) by a screen grid or two grid valve 12*a* having its anode-cathode space directly connected across the main condenser 1. The first grid 33*a* of this screen grid valve, i. e., the grid nearest the cathode 13*a*, is connected to the anode 45 of the third valve 24 and the outer grid 34 is coupled through a condenser 15*a* to the grid 16 of the second valve and is also connected through a resistance 35 to the positive terminal 2 of the source of potential. In other respects the circuit is as before.

In another modification shown in Fig. 3, the

first valve 12 is again a triode as in Fig. 1, but has its anode-cathode space directly connected across the main condenser 1 and an additional valve 12b, e. g. a triode, is provided, the cathode 13b of this additional valve being connected to the cathode 13 of the first valve 12 and the grid 33b of the said additional valve being connected to the grid 33 of the said first valve. The anode of the additional valve is connected to the positive terminal 2 through a resistance 36 and is also connected through a condenser 15b to the grid 16 of the second valve 17. In other respects the circuit is as in Fig. 1 and it will be appreciated that in this modification, also, very rapid discharging of the main condenser can be obtained since the anode-cathode space of the first valve 12 is connected directly across it.

Although in the illustrated embodiments resistances are utilized as coupling impedances, the invention is not limited to the use of resistances, since other suitable impedances may be employed. It is, however, preferred to use resistances in order to minimize frequency discrimination. Again, although in the illustrated embodiments the main condenser is slowly charged and suddenly discharged, it will be obvious to those skilled in the art that the equivalent "inverse" action may be obtained by means of the three-valve arrangement provided by the invention, i. e., the said three valve arrangement may be employed to cause periodically sudden charging of the condenser and slow discharging thereof.

As will be obvious, the invention may also be employed to provide multi-vibrator circuits for use for purposes other than time base control of cathode ray tube oscillographs.

What is claimed is:

1. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, circuit means for rendering said first device conductive and said second and third devices simultaneously non-conductive and for causing said first device to increase its conductivity upon said third device becoming non-conductive.

2. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, circuit means for rendering said first device conductive and said second and third devices simultaneously non-conductive and for causing said first device to increase its conductivity upon said third device becoming non-conductive, and a condenser adapted to be continuously charged connected across the electrodes of said first device, said condenser discharging across said first device upon being charged to a critical value, whereby said first device becomes non-conductive, and said second and third devices become conductive.

3. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, circuit means for rendering said first device conductive and said second and third devices simultaneously non-conductive and for causing said first device to increase its conductivity upon said third device becoming non-conductive, and a condenser adapted to be charged connected across the electrodes of said first device, said condenser discharging across said first device upon being charged to a critical value, whereby said first device becomes non-conductive, and said second and third devices become conductive, an output circuit connected across said condenser for obtaining high frequency oscillations from said generator, and means for applying synchronizing impulses to the input of said third device.

4. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, circuit means for periodically rendering said first device conductive and said second and third devices simultaneously non-conductive and for causing said first device to increase its conductivity upon said third device becoming non-conductive.

5. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, circuit means for rendering said first device conductive and said second and third devices simultaneously non-conductive and for causing said first device to increase its conductivity upon said third device becoming non-conductive, whereupon after a predetermined interval said first device becomes non-conductive and said second and third devices simultaneously become conductive.

6. An oscillation generator arrangement comprising first, second and third electron discharge devices, each having an anode, cathode and grid, a source of potential having positive and negative terminals, connections from said anodes to said positive terminal, a capacitive connection between the anode of said first device and the grid of said second device, a conductive connection from the cathode of said second device to the grid of the third device, and a conductive connection between the anode of said third device and the grid of said first device, and a connection from the cathode of said first device to said negative terminal, whereby the conductivity of said first device renders said second and third devices non-conductive.

7. A generator in accordance with claim 6, characterized in this that said last connection between the cathode of said first device and the negative terminal includes an electron discharge device whose anode is connected to said cathode and whose cathode is directly but whose grid is resistively connected to said negative terminal.

8. An oscillation generator comprising first, second and third electron discharge devices, each having an anode, cathode and grid, a source of potential having positive and negative terminals, resistive connections from said anodes to said positive terminal, a condenser across said posi-

tive terminal and the cathode of said first device, a capacitive connection between the anode of said first device and the grid of said second device, a grid leak resistance between the grid and cathode of said second device, a direct connection between the cathode of said second device and the grid of said third device, a direct connection between the anode of said third device and the grid of said first device, and connections from the cathodes of said devices to said negative terminal, whereby charging of said condenser to a predetermined value renders said first device conductive and said second and third devices non-conductive.

9. An oscillation generator in accordance with claim 8, including an output circuit for said generator coupled across said condenser, and means for applying synchronizing impulses between the cathode and an additional grid of said third device.

10. An oscillation generator in accordance with claim 8, including a fourth electron discharge device having an anode, cathode and grid, the grid and cathode of which are directly coupled, and the anode resistively coupled, respectively, to the corresponding electrodes of said first device.

11. An oscillation generator comprising first, second and third electron discharge devices, said first and third devices each having an anode, a cathode and two grids, and said second device an anode, a cathode, and a grid; a source of potential having positive and negative terminals, conductive connections from said anodes to said positive terminals, a resistive connection from one grid of said first device to said positive terminal and a capacitive connection from said same grid to the grid of said second device, a connection from the cathode of said second device to one grid of said third device, connections from said cathodes to said negative terminal, a connection from the anode of said third device to the remaining grid of said first device, an electrical charge storage element connected across the anode and cathode of said first device, and a source of synchronizing impulses connected to said remaining grid of said third device and said negative terminal, whereby charging of said storage element to a critical value will render said first device conductive and said second and third devices non-conductive.

12. An oscillation generator in accordance with claim 8, characterized in this that the resistive connections between the anodes of said first, second and third devices and said positive terminal are, respectively, of increasing value, in the order named.

13. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, a condenser connected across the space path of said first device, and circuit means for continuously charging said condenser, whereby said first device becomes conductive upon said condenser reaching a predetermined value and said second and third devices become non-conductive, said condenser discharging across said first device upon being charged to a critical value, whereby said first device becomes non-conductive and said second and third devices become conductive.

14. An oscillation generator comprising first, second and third electron discharge devices, each having input and output circuits, the output of said first device being coupled to the input of said second device, and the output of said third device being coupled to the input of said first device, both said second and third devices being coupled together, means for producing a gradually increasing potential across the space path of said first device, whereby said first device becomes conductive upon said increasing potential reaching a desired value and said second and third devices become non-conductive, said increasing potential abruptly decreasing when it reaches a critical value, whereby said first device becomes non-conductive and said second and third devices become conductive.

ARTHUR JAMES YOUNG.