PATENT SPECIFICATION

Application Date: April 14, 1937. No. 10613/37.

493,843

(Patent of Addition to 453,887, dated March 21, 1935.)

Complete Specification Accepted: Oct. 14, 1938.

COMPLETE SPECIFICATION

Electrical Circuits for Producing Currents or Voltages of Desired Wave Form

We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, and BERNARD NEWSAM, a British Subject, both of Connaught House, 63, Aldwych, London, W.C.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to electrical circuits for producing currents or voltages of desired wave form, and is a modification of the invention described and claimed in the Specification of Patent No. 453,887.

In the latter specification there is described and claimed apparatus for producing from electrical variations of a given wave form, electrical variations having a wave form which is an integration or a differentiation of the given wave form, said apparatus comprising an elementary integrating or differentiating circuit and means for feeding from the output side of the circuit to the input side thereof a compensating voltage which is in such phase relation and has such amplitude that there are delivered at the output terminals electrical variations having a wave form which is a substantially true integration or differentiation of the given wave form.

This was accomplished in the specific examples given by arranging an elementary differentiating or integrating circuit in the output circuit of one thermionic valve and in the input circuit of a second thermionic valve, and feeding back a certain proportion of the output voltage from the output of the latter to the input of the former, the electric waves to be integrated or differentiated being applied to the input circuit of the first thermionic valve.

The effect of this was to feed back part of the potential across the output of the elementary differentiating or integrating circuit and so to add this potential to the potential difference being differentiated or integrated.

The present invention applies a similar principle in order to obtain a uniform current or a uniform increase of current from a direct current source when there is a reactance in the circuit.

According to this invention we obtain a uniform flow of current from a d.c. source into a capacitative reactance or a uniform increase of current in an inductive reactance in a circuit containing also resistance by feeding back the potential across a portion of the circuit in series with the d.c. source.

One application of this invention is to a circuit for obtaining a uniformly increasing voltage or current for the purpose of traversing the beam of electrons in a cathode ray oscillograph in a uniform manner, with respect to time, commonly known as a time sweep circuit.

The nature of the invention will be better understood from the following description of certain embodiments thereof, taken in conjunction with the accompanying drawings in which Fig. 1, 1A, 2 and 3 are diagrams for explaining the application of the invention to circuits for producing a saw-tooth wave form, and Figs. 4, 5 and 6 are diagrams of circuits for producing such wave forms.

Referring to the drawings, it is well known that if a condenser B, Fig. 1A be charged through a resistance from a D.C. source the variation with time of the voltage across the condenser follows an exponential curve. This is due to the voltage across the condenser opposing the voltage across the resistance and in consequence reducing the charging current. It is usual, therefore, instead of charging the condenser through an ohmic resistance, to charge it through a device through which the current remains constant despite a variation in the voltage applied thereto, such as a pentode valve working under appropriate conditions. This results in a voltage across the condenser which varies in a nearly linear manner with time, but the compensation is not exact.

By means of the present invention we retain an ohmic resistance through which to charge the condenser but we maintain the voltage across the resistance constant.

This is obtained by superimposing upon the constant voltage applied to the resistance and condenser an exact replica of the voltage across the condenser. Thus if V_{DC} be the (constant) voltage of the D.C. source and V_{ab} be the (varying) voltage across the condenser, we apply a voltage of $V_{DC}+V_{ab}$ across both resistance and condenser. Then the voltage across the resistance is $V_{DC}+V_{ab}-V_{ab}$ i.e. V_{DC} which is a constant.

The effect of this is illustrated in Fig. 1 which shows the variations with time of the voltages across the points AC of Fig. 1A in the upper curve and the resultant variation of the voltage across the condenser B in the lower curve, when this condenser is periodically discharged to reduce the voltage across it to zero. Since the voltage across the resistance is a constant each ordinate of the lower curve differs from the corresponding ordinate of the upper curve by a constant amount and assuming there is no extraneous source of distortion in the circuits connected to Fig. 1A the rising portions of both curves are exactly linear. Extraneous sources of disturbance may exist and may be compensated by an increase or decrease of the voltage superposed on that of the D.C. source. Thus if the superposed voltage is less than V_{ab} an under compensated wave as shown in Fig. 2, if greater than V_{ab} an over compensated wave as shown in Fig. 3 will result. In each of these figures the upper curve is the voltage across A and C in Fig. 1A and the lower curve the voltage across the condenser only.

Fig. 4 shows a form of circuit according to the invention applied to the purpose of securing a linear increase with time of voltage across the condenser C. The condenser C is charged from the battery HT through the resistances R and R4. One side of condenser C is connected to the cathodes of valves V1 and V2 and to the negative pole of battery HT, the other side is connected through a condenser C3 and resistance R6 to the grid of the three electrode thermionic valve V1 having a suitable resistance R5 in its grid cathode circuit. Valve V1 is resistance capacity coupled to a second valve V2 in the plate circuit of which is the resistance R. In this way there is added to the direct voltage across the resistance R4 and condenser C derived from the battery H.T. a voltage which bears the desired ratio to the voltage across condenser C. The amplification of the two valve amplifier V1, V2 is adjusted to add to the voltage across the resistance R4 and condenser C derived from battery HT the variation in the voltage in the resistance R which is either exactly equal to that across condenser C or a little greater or less as previously described with reference to Figs. 1 to 3. A discharge device D is, as usual, connected across the condenser C and discharges that condenser as rapidly as possible as soon as the voltage across it reaches a predetermined value.

Two valves are used in order to give a balanced sweep circuit i.e. a circuit in which the voltages of the two deflecting plates vary in opposite directions with respect to the electrodes of the cathode ray tube which are maintained at a fixed potential. The final anode of the cathode ray tube is connected to the common cathode circuit of the valves V1 and V2 which may be grounded whilst the deflecting plates Dx1 and Dx2 are connected to the anodes of the respective valves V1 and V2 through suitable condensers since the potential of these anodes varies in opposite directions.

Fig. 5 shows the application of the invention to secure a current in an inductance increasing linearly with time. The inductance L in this case consists of the magnetic deflecting coils of a cathode ray tube the resistance LR of these coils being represented as in series therewith.

This case corresponds with the circuit for effecting a true differentiation described in Specification No. 453,887, the previous case (Fig. 4) corresponding with the circuit for integration. In the circuit of Fig. 5, therefore, the voltage across the inductance coils is maintained constant. In the circuit shown current passes through the deflecting coils when the discharge device D is conducting. To the constant voltage V_{DC} across the inductance L, its resistance LR and a resistance R_4 in series therewith is added the voltage V_{R_4} across the resistance R_4 so that the total voltage impressed across inductance L and resistance LR and R_4 is $V_{DC}+V_{R_4}$. The voltage across the inductance L and resistance LR is then V_{DC} a constant. In the familiar equation $l\frac{di}{dt}+ri=e$, e becomes a constant and therefore $l\frac{di}{dt}$ is a constant and the current rises linearly with time.

Fig. 6 shows a circuit by means of which a balanced sweep may be obtained by means of only one thermionic valve V1. This is accomplished by dividing the resistance (R1, R2) in the anode circuit of the valve and placing part of this resistance (R1) between the cathode and the condenser C, the voltage across which is to determine the deflection of the electron beam. The condenser C is charged from the constant source HT through resistances R_3 and R_4. The voltage across condenser C is applied through condenser C1 across the grid and cathode of the valve V1 and resistance R1. A point on resistance R1 is connected through a high resistance R5 to the grid of the valve to apply an appropriate grid bias. The output of valve V1 is taken from the terminals of resistances R1 and R2 and applied across the resistances R3 and R4 and condenser C. The connection shown is used to obtain a ratio of amplification which is almost one. The deflecting plates Dx_1 and Dx_2 are connected through condensers to the anode and cathode of valve V1, whilst the anode AN of the cathode ray tube is connected to the negative end of the resistance R1. In order to secure an accurately balanced sweep the values of the resistances R_1, R_2 and R_3 are so proportioned that $R_2 = \frac{R_1 \quad R_3}{R_1 + R_3}$. If ($V_{OUT}$) is the output voltage of valve V1 applied across resistances R3 and R4 and condenser C, and V_{IN} be the input voltage:—

$$V_{(OUT)} = V_{(IN)} \frac{UR_1}{(U+1)\ R_1 + R_2 + Z}$$

where U is the amplification factor of the valve and Z its plate impedance. The effective amplification in this case must therefore always be less than unity, and the exponential charging curve is undercompensated. The compensation may, however, be made very close to unity. In a typical case R1 and R2 were each chosen as 50,000 ohms, R3 was therefore 250,000 ohms. Using a valve having an amplification factor of 80 and a plate impedance 13,300 ohms, the ratio of compensation is 0.99. In this case R4 was chosen as 250,000 ohms, and the condenser C as variable between 0.01 and 0.005.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of obtaining a uniform current from a direct current source into a capacitative reactance or a uniformly increasing current through an inductive reactance in a circuit containing also resistance which consists in feeding back the potential across a portion of the circuit and adding it to the potential derived from the direct current source.

2. A method as claimed in claim 1 in which the potential across a capacitative reactance derived from a direct current source is fed back through a thermionic valve or valves and added to the potential which is derived from the said source and applied across the said condenser and a resistance.

3. A method as claimed in claim 1 in which the potential across a resistance connected in series with an inductive reactance is fed back through a thermionic valve or valves and added to the potential derived from the direct current source which is applied across both resistance and reactance.

4. A linear or substantially linear time sweep circuit for a cathode ray tube in which current flows from a direct current source through a resistance into a reactance element the current through which or the voltage across which is used to traverse an electron stream across the screen or like element of a cathode ray tube and in which, in order that the voltage across part of said circuit shall be regulated to a desired degree of constancy, a desired proportion of the varying voltage across the remainder of the circuit is added to that derived from the direct current source applied across the whole of the circuit.

5. A linear or substantially linear time sweep circuit for a cathode ray tube comprising a resistance in series with a condenser, a direct current source connected across both the said resistance and the said condenser, and a thermionic valve circuit having the said condenser connected in its input circuit and having its output circuit connected across the said resistance and condenser, the ratio of the input and output voltages of the said thermionic valve circuit being adjusted to be nearly equal to unity.

6. A linear or substantially linear time sweep circuit for a cathode ray tube comprising a coil for creating a magnetic field for the deflection of a beam of electrons in the said tube, a resistance in series with the said coil, a direct current source connected across both said coil and said resistance, a thermionic valve circuit having the said resistance connected in its input circuit and having the said coil and said resistance in series in its output circuit, the ratio of the input and output voltages of the said thermionic valve circuit being adjusted to be nearly equal to unity.

7. A time sweep circuit for a cathode ray tube as claimed in claim 5 in which said thermionic valve circuit consists of

two thermionic valves connected in cascade and in which the two deflecting plates of a pair of such plates in the cathode ray tube are connected to the respective anodes of the two valves, the anode of the cathode ray tube being connected to a common point of the anode circuits of both valves.

8. A time sweep circuit for a cathode ray tube substantially as described with reference to Fig. 4, or to Fig. 5 or to Fig. 6 of the accompanying drawings.

Dated this 14th day of April A.D. 1937.

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Fig. 1.

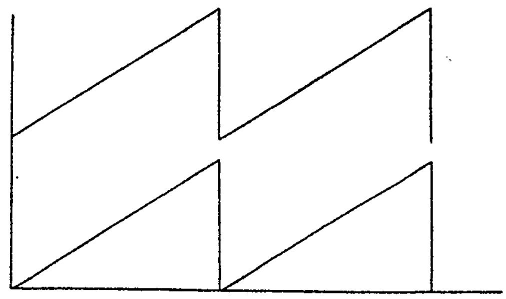


Fig. 1A

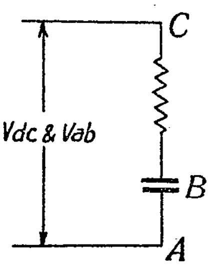


Fig. 2.

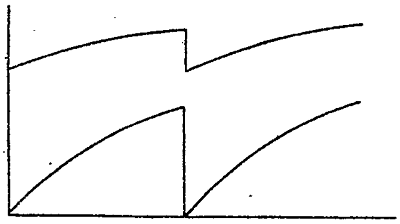


Fig. 3.

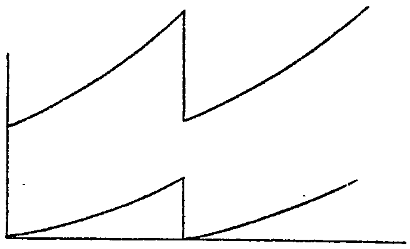
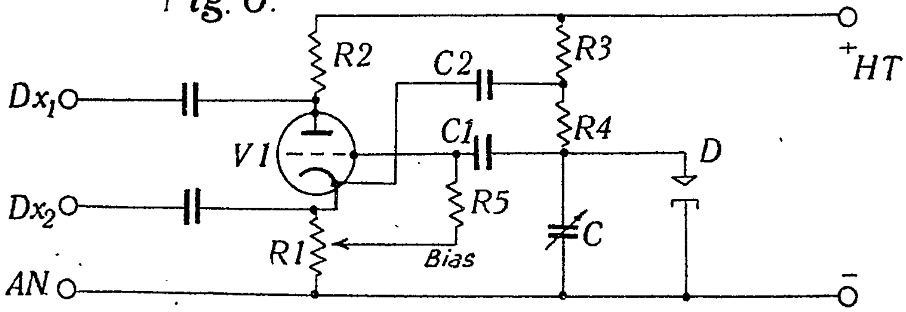


Fig. 6.



2 SHEETS
SHEET 2

SHEET 1

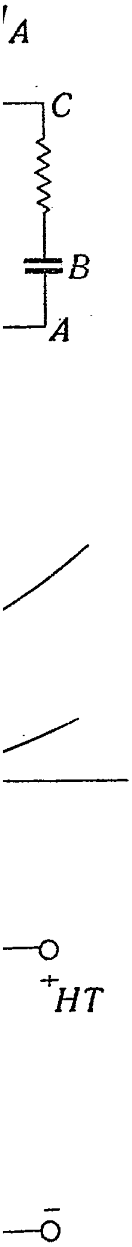


Fig. 4.

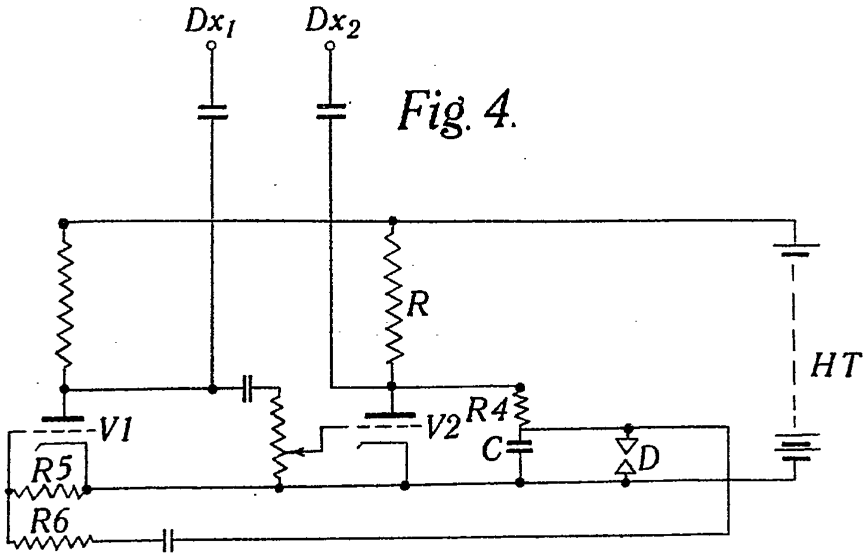
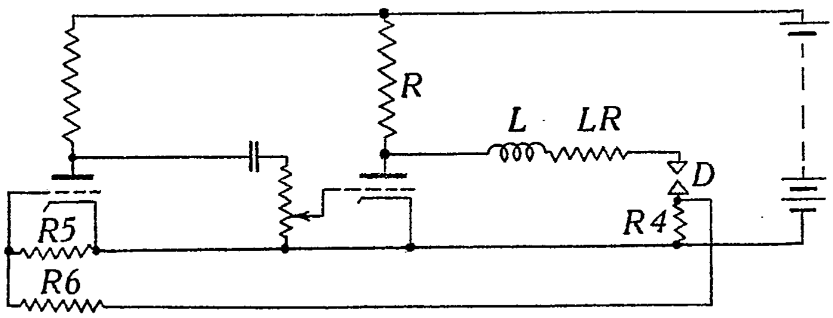


Fig. 5.



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[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

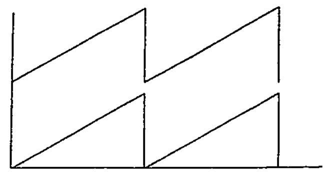

Fig. 1A

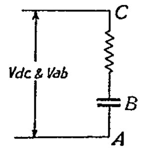

Fig. 2.

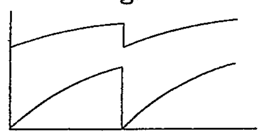

Fig. 3.

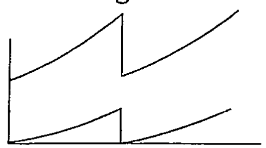

Fig. 6.

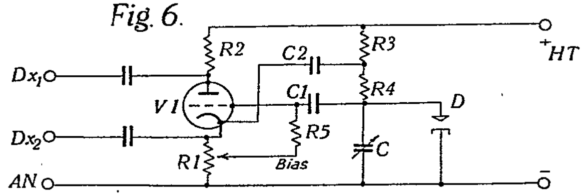

Fig. 4.

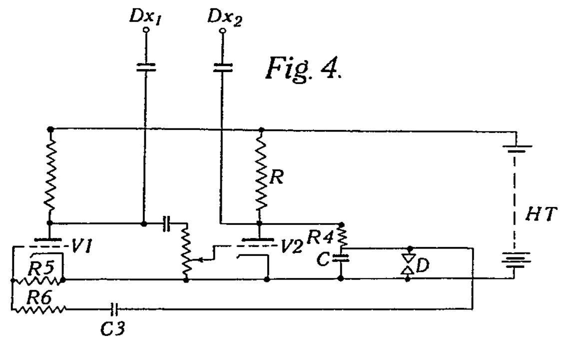

Fig. 5.