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2,403,487

CATHODE RAY DEFLECTION CIRCUIT

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FIG. 1.

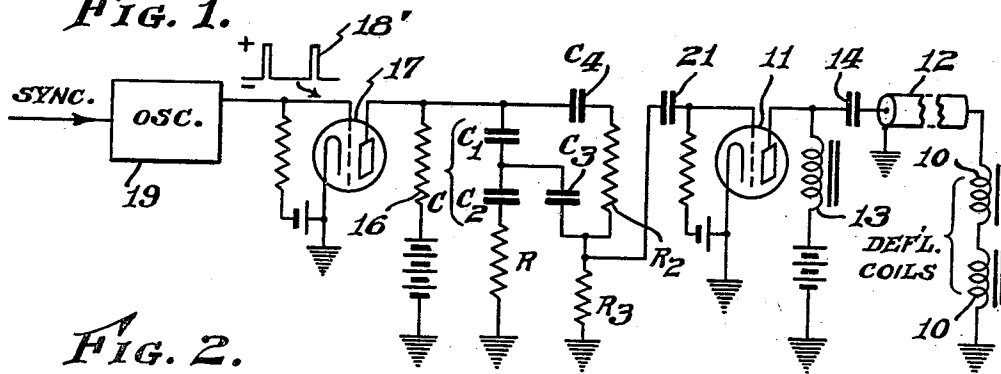


FIG. 2.

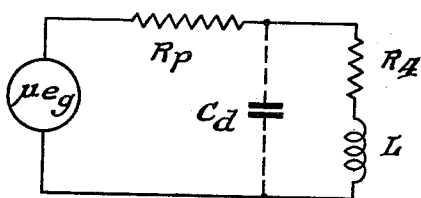
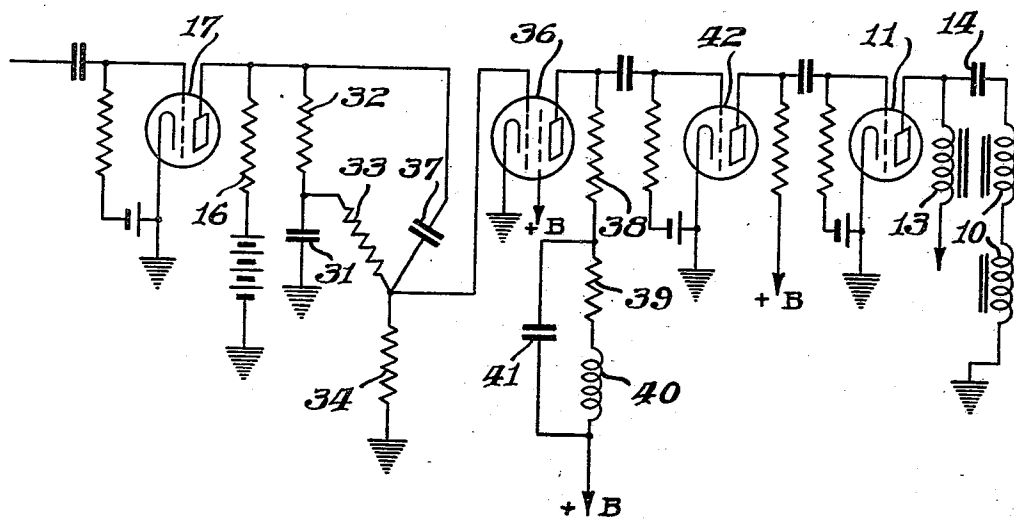


FIG. 3.



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CATHODE-RAY DEFLECTION CIRCUIT

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6 Claims. (Cl. 315-27)

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My invention relates to cathode ray deflection circuits and particularly to circuits employing electromagnetic deflection.

One of the more difficult problems in designing a deflecting circuit is that of obtaining the desired deflecting current wave shape. It is especially difficult in cases where the deflecting coils have a substantial amount of distributed capacity and where either the deflecting coil resistance itself, or the coil resistance together with the resistance of a cable or the like, is rather high.

An object of the present invention is to provide an improved method of and means for producing a flow of deflecting current of the desired wave shape.

A further object of the invention is to provide an improved electromagnetic deflecting circuit for use with deflecting coils having a substantial amount of resistance and distributed capacity.

A still further object of the invention is to provide an improved deflecting circuit for passing a sawtooth current through deflecting coils having a substantial amount of resistance effectively in series therewith and a substantial amount of capacity effectively in shunt thereto.

In one embodiment of the invention, a special network preceding the deflecting circuit output tube adds voltages from two circuit branches to supply to the grid of this tube (1) a voltage that would give the desired sawtooth current in the absence of capacity across the deflecting coil and (2) an additional voltage that supplies the current taken by the capacity, this additional voltage being given a wave shape which takes into consideration the deflecting coil resistance and/or cable resistance or the like in series with the coil.

In a preferred embodiment, there is a network preceding the output tube which simulates the output circuit of said tube, this network including a condenser corresponding to distributed capacity and being itself preceded by a wave shaping means for producing current of the proper wave shape through the said network.

The invention will be better understood from the following description taken in connection with the accompanying drawing, in which

Fig. 1 is a circuit diagram of a deflecting circuit embodying my invention,

Fig. 2 is a diagram of an equivalent circuit for a portion of the circuit in Fig. 1, and

Fig. 3 is a circuit diagram of a preferred embodiment of the invention.

Corresponding parts in the several figures are indicated by like reference characters.

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Referring to Fig. 1, the invention is shown applied to a cathode ray deflecting circuit comprising deflecting coils 10 which are supplied through a cable 12 with deflecting current from an output tube 11. The output circuit of tube 11 may include a conventional choke coil 13 and blocking condenser 14.

One of the voltage wave components applied to the grid of the output tube 11 consists of the usual sawtooth wave combined with a rectangular pulse. This portion of the wave is produced by a capacitor C comprising condensers C1 and C2 in series with each other and in series with a "peaking" resistor R. The capacitor C is charged comparatively slowly through a plate resistor 16 and is discharged rapidly through a discharge tube 17 in response to the application of a positive pulse 18 to the grid thereof.

The pulses 18 may be supplied to the discharge tube 17 from any suitable source such as a blocking oscillator indicated at 19.

The combined sawtooth-pulse wave across C-R is impressed across a potentiometer circuit comprising a blocking condenser C4 and the resistors R2 and R3, all connected in series. The voltage across resistor R3, which has a low resistance compared with that of R2, is applied to the grid of the output tube 11 through the usual coupling condenser 21. The potentiometer circuit does not appreciably load the capacitor C since the resistance of R2 is made great enough to give R2-C a time constant that is long compared with a deflection cycle.

In accordance with my invention, another voltage wave is added to the above-mentioned sawtooth-pulse wave by means of a condenser C3 connected between the junction point of condensers C1 and C2 and the junction point of resistors R2 and R3. This connects C3 and R3 across condenser C2 and peaking resistor R whereby a voltage that is the differential of the voltage across C2-R appears across R3 and is added to the other voltage wave, that is, to the combined sawtooth-pulse wave.

The above described differentiation is obtained since the impedance of R3 is low compared with that of C3 whereby the current flow through C3 (and through R3) is given by the equation

$$i_c = C \frac{dE}{dt}$$

where C is the capacity of condenser C3 and E is the voltage across C2 and R.

The circuit operation will be understood by referring to Fig. 2 where R_p represents the cath-

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ode-plate resistance of the output tube 11, R_4 represents the deflecting coil resistance and any other resistance in series therewith, such as all or part of the resistance of the cable 12, L represents the inductance of the deflecting coils 10, and C_a represents the distributed capacity of the coils 10 and any additional capacity across them such as the capacity of the cable 12.

The circuit operation of Fig. 1 may be analyzed as follows:

The combined sawtooth-pulse voltage across C—R consists of a sawtooth voltage across C_1 , another sawtooth voltage across C_2 and a pulse voltage across R. The voltages across C_1 and C_2 are those required to drive a sawtooth current through R_p and through R_4 , respectively, and the voltage across R is that required to drive a sawtooth current through the inductance L . No other voltage at the grid of tube 11 would be required if the distributed capacity C_a were absent.

However, there is the capacity C_a across R_4 and L which will draw current. I provide this current by the additional differentiated voltage obtained by the circuit C3—R3 connected across C2—R. It will be apparent that the voltage across C2—R is a sawtooth wave plus a pulse, just as the voltage across R_4 and L is a sawtooth wave plus a pulse. Therefore, the differentiated voltage appearing across R3 is the voltage required to supply current to the distributed capacity C_a for the assumed desired condition of a straight or undistorted sawtooth current flowing through the inductance L , that is, through the deflecting coils 10.

It may be noted that the operation of that portion of the above circuit for supplying the capacity current for C_a is based on the assumption that the output tube feeds into a pure resistive load so far as the grid voltage vs. plate current characteristic is concerned. This assumption, of course, is not strictly true.

Fig. 3 shows a preferred embodiment of the invention which corrects more exactly for the capacity across the deflecting coils 10. In the output circuit of the tube 17 there is a condenser 31 across which a sawtooth voltage appears and a resistor 32 across which a pulse voltage appears.

A potentiometer comprising resistors 33 and 34 is connected across condenser 31, and the input electrodes of an amplifier tube 36 are connected across resistor 34.

The combined sawtooth and pulse voltage appearing across the condenser 31 and the resistor 32 is differentiated in a circuit comprising a condenser 37 and the resistor 34. This differentiated voltage is added in the resistor 34 to the sawtooth voltage whereby the combined voltage wave is impressed upon the grid of amplifier 36.

In the plate circuit of amplifier 36 there is a network which simulates the output circuit of the output tube 11, this output circuit being shown in equivalent form in Fig. 2. The network comprises a resistor 38 corresponding to R_p (Fig. 2), a resistor 39 corresponding to R_4 , an inductance coil 40 corresponding to the inductance L of coils 10, and a condenser 41 corresponding to distributed capacity C_a . The tube 36 is of a type having such high plate impedance with respect to its plate circuit that the plate current is closely proportional to the grid voltage. As will be explained, the voltage appearing across this network is the voltage which, when applied to the grid of the output tube 11 will produce current through the deflecting coils that is a straight sawtooth.

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The network voltage is applied to the grid of tube 11 through an amplifier 42 for reversing its polarity, it being preferred that the tube 11 be driven towards plate current cutoff during the return-line time as is well known in the art. The tube 11 functions, however, as a substantially linear amplifier.

Considering the function of the above-described network more in detail, it will be apparent that the sawtooth voltage component applied to the grid of tube 36 produces a voltage pulse across coil 40 and a voltage sawtooth across the resistors 38 and 39. In the absence of capacity across the deflecting coils this would produce a straight sawtooth current in the deflecting coils.

The value of the resistor 32 with respect to the condenser 31 is such that the voltage wave applied to the differentiating condenser 37, is the same shape as the voltage which would exist across C_a , when a straight sawtooth current flows through R_4 and L . Hence, the current through condenser 37 corresponds to the current through C_a and generates a component of IR drop in resistor 34 which causes a similar component of current to flow into the network 38, 39, 40 and 41. The flow of this component of current then results in a voltage component being applied to the grid of tube 42 (and then to the grid of tube 11) which is correct to cause tube 11 to supply the desired capacity component of current to its actual output circuit. Therefore, the voltage appearing across the network 38, 39, 40 and 41 when applied to the grid of the output tube causes the desired undistorted sawtooth current to flow through the deflecting coils.

I claim as my invention:

1. A cathode ray deflecting circuit comprising deflecting coils having distributed capacity thereacross and having resistance effectively in series therewith, a vacuum tube having a grid circuit and having a plate circuit coupled to said coils to supply deflecting current therethrough, a capacitor and a resistor in series, means for producing a sawtooth voltage wave across said capacitor and a voltage pulse across said resistor, means comprising a branch circuit connected across said capacitor and resistor for differentiating the voltage appearing across said resistor and at least a portion of the voltage appearing across said capacitor, means for adding said differentiated voltage to at least a portion of the voltage appearing across said capacitor, and means for impressing said added voltages upon said grid circuit.

2. A cathode ray deflecting circuit comprising deflecting coils having distributed capacity thereacross and having resistance effectively in series therewith, a vacuum tube having a grid circuit and having a plate circuit coupled to said coils to supply deflecting current therethrough, a plurality of condensers in series with a peaking resistor, means for producing a sawtooth voltage wave across each of condensers and a voltage pulse across said peaking resistor, means for differentiating the voltage appearing across said resistor and across at least one but not all of said condensers, means for adding said differentiated voltage to the voltage appearing across said peaking resistor and said plurality of condensers, and means for impressing said added voltages upon said grid circuit.

3. A cathode ray deflecting circuit comprising deflecting coils having distributed capacity thereacross and having resistance effectively in series therewith, an output tube coupled to said coils to

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supply deflecting current therethrough, a plurality of amplifier tubes connected in cascade with said output tube, each of said amplifier tubes having a grid circuit and a plate circuit, a network in the plate circuit of one of said tubes which simulates the output circuit of said output tube, said network comprising an inductance coil and a resistor in series, both shunted by a condenser representing said distributed capacity to form a parallel combination of elements, and a resistor connected in series with said parallel combination, and means for applying to the grid of said one tube a voltage consisting of a sawtooth component and a component which is a derivative of said sawtooth component and of a voltage pulse.

4. A cathode ray deflecting circuit comprising deflecting coils having distributed capacity thereacross and having resistance effectively in series therewith, an output tube coupled to said coils to supply deflecting current therethrough, a plurality of amplifier tubes connected in cascade with said output tube, each of said amplifier tubes having a grid circuit and a plate circuit, a network in the plate circuit of one of said tubes which simulates the output circuit of said output tube, said network comprising an inductance coil representing deflecting coil inductance and a resistor in series representing said resistance effectively in series, both shunted by a condenser representing said distributed capacity to form a parallel combination of elements, and a resistor representing the plate-cathode resistance of said output tube connected in series with said parallel combination, said network having an impedance which is proportional to the impedance of the load circuit of said output tube, said load circuit including the plate-cathode resistance of the output tube; and means for applying to the grid of said one tube a voltage consisting of a saw-

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tooth component and a component which is a derivative of said sawtooth component and of a voltage pulse.

5. A cathode ray deflecting circuit comprising deflecting coils having distributed capacity thereacross and having resistance effectively in series therewith, an output tube coupled to said coils to supply deflecting current therethrough, a plurality of amplifier tubes connected in cascade with said output tube, each of said amplifier tubes having a grid circuit and a plate circuit, a network in the plate circuit of one of said tubes which simulates the output circuit of said output tube, said network comprising an inductance coil representing deflecting coil inductance and a resistor in series representing said resistance effectively in series, both shunted by a condenser representing said distributed capacity to form a parallel combination of elements, and a resistor representing the plate-cathode resistance of said output tube connected in series with said parallel combination, and means for applying to the grid of said one tube a voltage consisting of a sawtooth component for producing the voltage drop across said inductance coil and a component which is a derivative of said sawtooth component and of a voltage pulse.

6. The invention according to claim 5 wherein said last means comprises a resistor and a condenser in series and means for producing a sawtooth voltage across said condenser and a pulse voltage across said last resistor, means for obtaining a derivative of the voltages appearing across said last mentioned series combination of resistor and condenser, and means for adding said last sawtooth voltage and said derivative voltage and applying them to the grid of said one tube.

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