May 26, 1942. R. B. DOME 2,284,378

DEFLECTING CIRCUIT

Filed May 3, 1940

Fig. 1.

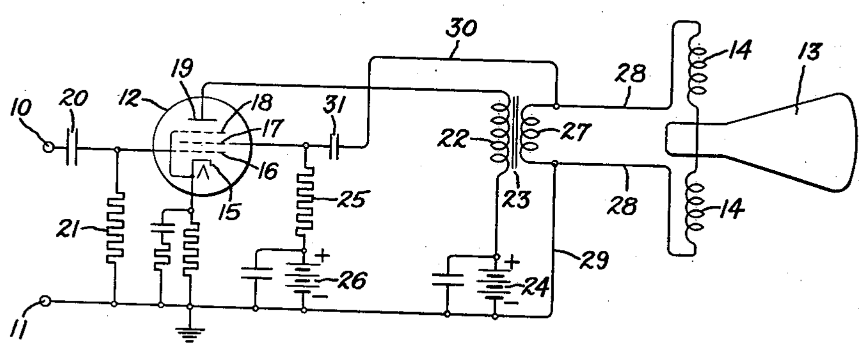


Fig. 2.

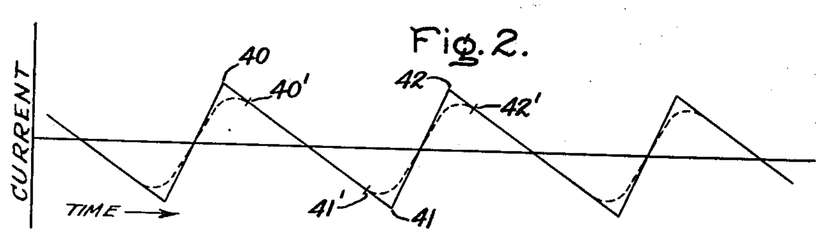
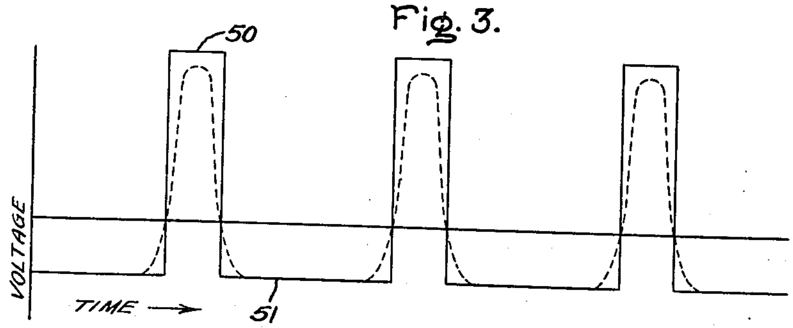


Fig. 3.



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2,284,378

DEFLECTING CIRCUIT

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4 Claims. (Cl. 250—27)

My invention relates to deflecting circuits for cathode ray apparatus, and more particularly to a circuit for producing a flow of current of desired wave shape through a deflecting element such as the deflecting coil, or coils, of a cathode ray discharge device.

In the operation of cathode ray discharge devices of various types, such as are widely employed in television equipment, wave analyzing apparatus and the like, it is often desirable to produce a current flow through a magnetic ray deflecting element which is of substantially pure sawtooth wave form. The wave form desired is usually that which will cause deflection of the cathode ray in one direction at a substantially constant time rate during the useful portion of a cycle, or interval of trace, and the return of the ray to its initial position at a very much higher time rate during the non-useful portion of a cycle, or interval of retrace. Practical attainment of these conditions is usually difficult. In particular, distortion of the wave form during the retrace interval is often encountered due to the inductance of the deflecting coil, or coils, and the damping effect of the associated circuits thereon. The net result is an increase in the time interval required for retrace with consequent reduction in the portion of a cycle which may be employed usefully.

It is accordingly an object of my invention to provide an improved deflecting circuit for producing a flow of current of desired wave shape in a magnetic deflecting means.

A further object of my invention is to provide means for reducing the time interval required for the non-useful retrace portion of a sawtooth current wave flowing in a ray deflecting element.

In accordance with my invention I provide means for deriving a potential depending in magnitude and polarity on the rate of change of a current wave in a ray deflecting inductive element and for controlling the damping of the deflecting circuit thereby in such a manner as to improve the operating characteristics thereof.

More specifically my invention contemplates a ray deflecting circuit which includes a thermionic amplifying device for supplying sawtooth current waves to a magnetic deflecting element and means for varying the anode to cathode impedance of said device in accordance with a function of the shape of said waves so as to effect an improvement in the current wave shape.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 is a circuit diagram of one embodiment of my invention, and Figs. 2 and 3 are curves helpful in analyzing the electrical characteristics of the circuit of Fig. 1.

Referring now to Fig. 1 of the drawing, control potentials of the desired wave shape are impressed upon the input terminals 10 and 11 of an electron discharge amplifier 12. Coupled to the output circuit of the amplifier 12 is the current responsive deflecting element of a conventional cathode ray discharge device 13, illustrated as a pair of inductance coils 14. The device 13 may be any type of cathode ray known to the art for developing and projecting a cathode ray, the deflection of which along one coordinate axis is controlled by the deflecting coils 14. The structural details of this device, which are entirely conventional, form no part of my invention and are therefore not illustrated. It will of course be understood that the device 13 may be provided with other coordinate deflecting circuits which may be substantially duplicates of that illustrated or of any other suitable types known to the art.

The device 12 has been illustrated as a pentode of conventional type having an indirectly heated cathode 15, control grid 16, screen grid 17, suppressor grid 18 and anode 19. Potentials impressed on the terminals 10 and 11 from any suitable source, not shown, are coupled to the control grid 16 in any suitable manner, as by the capacity-resistance network 20, 21.

The anode circuit for the device 10 includes the primary winding 22 of a transformer 23 and a suitable source of anode potential, such as the battery 24. The transformer 23 is of any suitable design for coupling sawtooth waves to the deflecting coils 14. If the sweep frequency is relatively low, as for example 60 cycles, it may be of the iron core type as illustrated.

Positive potential is applied to the screen grid 17 through an impedance 25 and a source of potential, illustrated as the battery 26, in the usual manner.

The secondary winding 27 of the output transformer 23 is connected in an output circuit with the coils 14 through the conductors 28. The coils 14 are illustrated as being connected in series in a conventional manner. Of course it will be understood that they may be connected in parallel, or that the deflecting element may comprise only a single coil.

In accordance with my invention means are provided for applying alternating potentials developed across the secondary winding 27 and deflecting coils 14 upon the screen grid 17. This is illustrated as a conductive connection including the conductor 29 between the lower terminal of the winding 27 and the cathode 15, and a connection between the upper terminal of the winding 27 and screen grid 17 through conductor 30 and capacitor 31.

In the operation of the illustrated embodiment of my invention, assume that potential waves of the desired shape are impressed upon the input terminals 10 and 11. Under ideal conditions corresponding sawtooth current waves will be produced in the deflecting coils 14, as for example, of the shape indicated by the solid line curve of Fig. 2. The straight line portion 40, 41 indicates the variation in current through the deflecting coils 14 during the useful portion of a cycle, that is, the interval of trace. The straight line portion 41, 42, which is of much steeper reversed slope, indicates the non-useful portion of the cycle during which the current changes rapidly back to the original value which it had at the beginning of the cycle, that is, the interval of retrace.

In practice, this ideal wave form may be distorted, due to the inductance of the coils 14, the characteristics of the transformer 23, and particularly the damping effect of the anode to cathode resistance of device 12, which is connected in circuit with the primary winding 22. Distortion is particularly noticeable during the retrace interval when the rate of change of current in the deflecting coils is relatively great. The general effect is to round off the peaks of the ideal curve of Fig. 2 as indicated by the dotted portions, for example. It will be observed that the average slope of the curve during the retrace interval is now decreased and that the linear portion of the curve which may be utilized during trace is also reduced as, for example, to the interval 40′, 41′. The non-useful interval of retrace is correspondingly increased, as between the points 41′ and 42′.

The sawtooth current through the inductive deflecting coils 14 produces across the secondary winding 27 a voltage which is substantially the first derivative of the current wave shape. As is indicated graphically in Fig. 3, this produces a high peak of voltage 50 in one direction during the time interval of retrace and a correspondingly lower voltage peak 51 during the time interval of trace. The aforesaid distortion of the current wave necessarily also distorts the shape of this idealized solid line voltage wave, as indicated by the dotted portions, for example. A point on the output circuit 27, 28, 14, preferably the upper terminal of the secondary winding 27, is connected to the conductor 30 so that the high peak of voltage 50 polarizes the screen grid 17 in a negative direction with respect to the direct current potential applied to the screen grid 17 from the battery 26.

As a result of the feedback circuit between the cathode 15 and screen grid 17 through the conductor 29, winding 27 and coils 14 in parallel, conductor 30 and capacitor 31, the screen grid is rendered more negative with respect to the cathode 15 during the retrace interval. The capacitor 31 also prevents the application of a direct potential from source 26 upon the coils 14. If the sweep frequency is 60 cycles, for example, a suitable value for the capacitor 31 may be 0.1 mfd.

The resistor 25 serves to couple the feedback voltages derived from the secondary winding 27 between the screen grid 17 and cathode 15. It also serves as a conduction means for the average screen grid current and prevents short circuiting the winding 27 for the alternating potentials thereacross.

It is a well known characteristic of a pentode amplifier that the anode to cathode resistance, or plate resistance, is a function of the screen grid potential. This resistance increases as the screen grid potential decreases and approaches infinity at zero voltages. Expressed another way, the mutual conductance of the amplifier varies in the same sense as the screen grid potential. Thus, during the interval of trace the anode to cathode resistance of the pentode 12 decreases by a relatively small amount in accordance with the peaks 51. Since the slope of the sawtooth waves is relatively gradual during this interval, this effect is of minor importance. However, during the retrace interval the relatively high negative potential peak 50 is impressed on the screen grid through capacitor 31. The anode to cathode resistance of the pentode arises to a high value. This means that the current in the primary winding 22 of the transformer 23 drops to a low value. This value is theoretically zero, though in reality, due to the capacity of the transformer windings, the current drops back quickly to the value it had at the beginning of the trace period. Consequently, the rate of change of current in transformer 23 is accelerated appreciably and the anode to cathode resistance of the device 10 exerts a reduced damping effect upon the deflecting coils 14. The retrace time is reduced and a closer approach to the ideal current wave shape of Fig. 2 is obtained.

While I have illustrated the device 12 in the preferred embodiment of my invention as a pentode having the mutual conductance thereof varied in accordance with the control of the screen grid potential, of course other suitable types of thermionic devices will readily suggest themselves to those skilled in the art. Thus, a screen grid tube rather than a pentode may be employed. The control potential impressed through capacitor 31 may also be applied to some control element other than the screen grid, although I have found that control of the screen grid potential is most satisfactory for the purposes to which my invention is best adapted. Thus, while I have illustrated a preferred embodiment of my invention, it will be understood that I do not wish to be limited thereto and that I intend to cover by the appended claims any modifications that fall within the true spirit and scope thereof.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a ray deflecting circuit for a cathode ray discharge device, the combination of a current responsive ray deflecting means, a thermionic discharge device having input and output circuits, a transformer having a primary winding in said output circuit and a secondary winding in circuit with said current responsive means, means to impress sawtooth voltage waves on said input circuit having a relatively gradual rate of change in one direction during intervals of

trace and a relatively high rate of change in the opposite direction during intervals of retrace, whereby current waves are caused to flow in said ray deflecting means which produce a relatively low positive potential across said secondary winding during intervals of trace and a relatively high negative potential thereacross during intervals of retrace, and feedback means for supplying said potentials to said discharge device in proper phase to increase the plate resistance of said device substantially during intervals of retrace.

2. In combination, a thermionic device having an anode, a cathode and a plurality of grids, an input circuit between said cathode and one of said grids, a circuit between said anode and said cathode including the primary winding of an output transformer, an output circuit including the secondary winding of said transformer and a deflecting coil, and means for feeding back voltages to said device which are proportional to the voltages developed across said coil, said means comprising a conductive connection between a point on said output circuit and said cathode and an alternating current connection between another point on said output circuit and another of said grids.

3. A ray deflecting circuit for a cathode ray discharge device comprising, in combination, a magnetic deflecting coil, a thermionic amplifier having a cathode, a control grid, a screen grid and an anode, a transformer having primary and secondary windings, an anode to cathode circuit including said primary winding, an output circuit including said secondary winding and said deflecting coil, a source of sawtooth sweep frequency voltage waves having a relatively gradual time rate of change in one sense during intervals of trace and a relatively high time rate of change in the opposite sense during intervals of retrace, means connecting said source between said control grid and cathode, a connection between one end of said secondary winding and said cathode, whereby current waves are caused to flow in said output circuit which polarize said secondary winding with respect to said cathode with a relatively low positive potential during intervals of trace and a relatively high negative potential during intervals of retrace, and means responsive to said potentials for increasing said plate resistance substantially during intervals of retrace, said means comprising a capacitor of low impedance at the sweep frequency connected between a point on said secondary winding and said screen grid.

4. In combination with a cathode ray device having magnetic deflecting coils, a high impedance amplifier having a cathode, a control grid, a screen grid and an anode, a transformer having a primary winding connected in circuit between said anode and cathode and a secondary winding connected in circuit with said coils, a source of sawtooth voltage waves connected between said control grid and cathode, whereby current waves are caused to flow in said circuits, and circuit connections between said screen grid and cathode including said secondary winding, said secondary winding being poled to impress a voltage between said screen grid and cathode which biases said screen grid negatively when the current flowing in said anode to cathode circuit is decreasing.

ROBERT B. DOME.