

April 21, 1942.

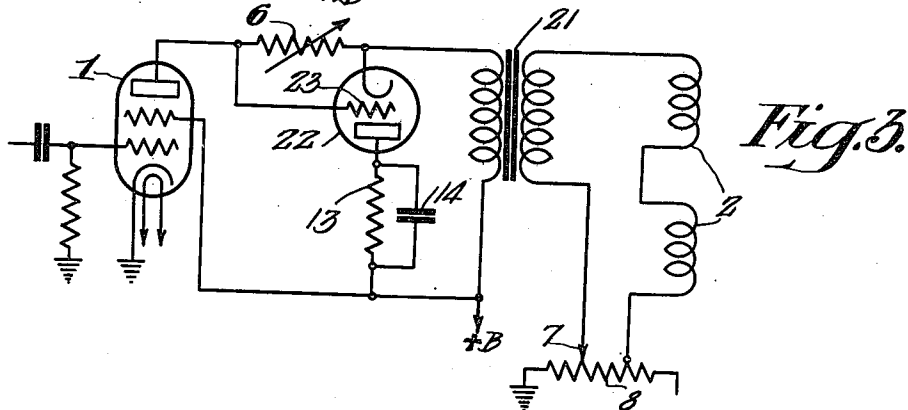
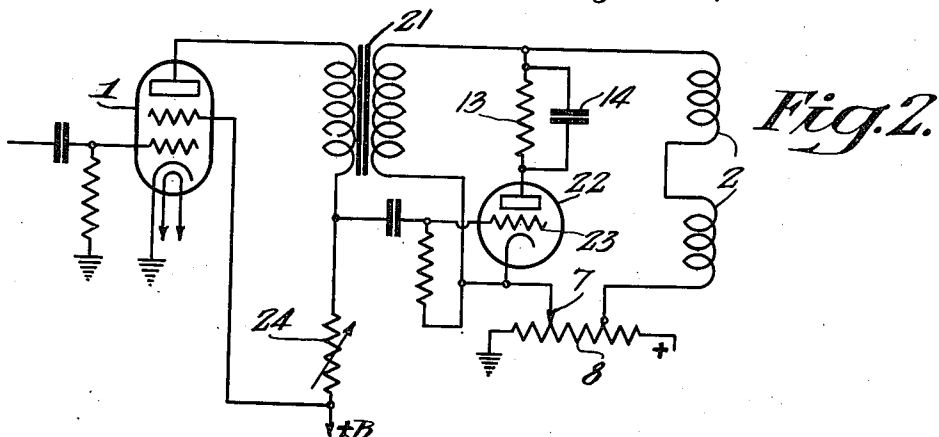
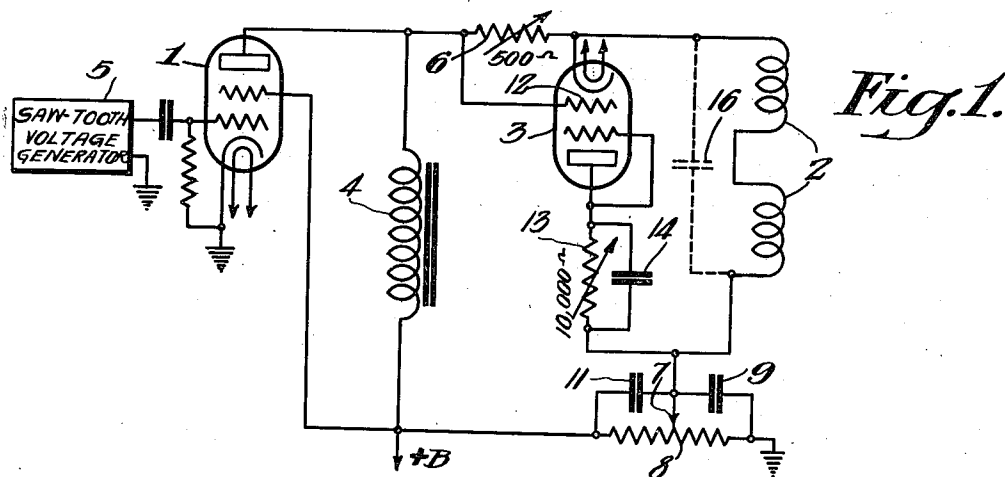
W. A. TOLSON

2,280,733

DEFLECTING CIRCUITS

Filed June 30, 1939

3 Sheets-Sheet 1



By

Inventor
William A. Tolson
[Signature]
 Attorney

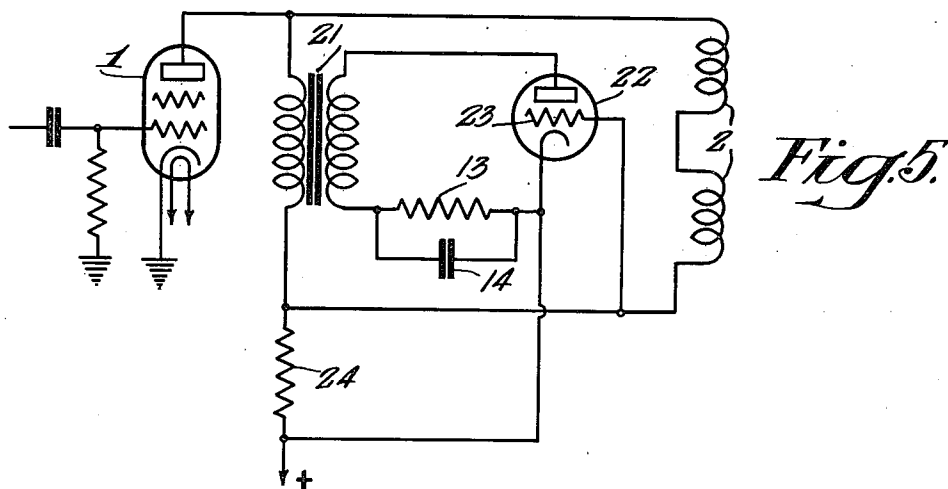
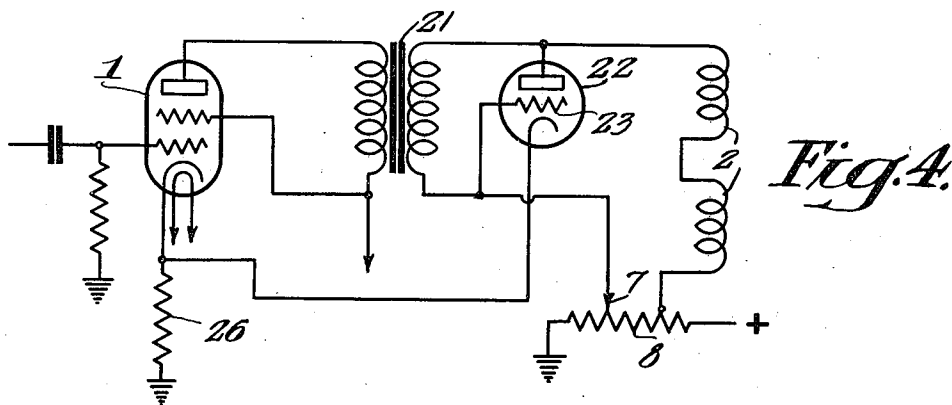
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 6.

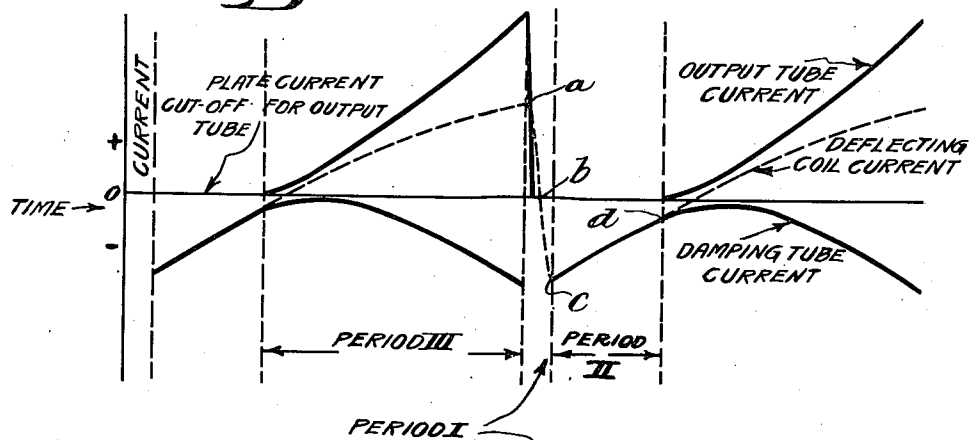


Fig. 7.

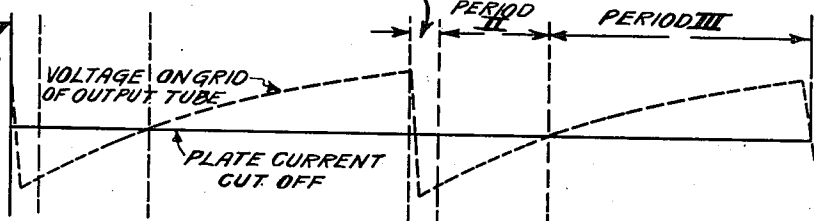
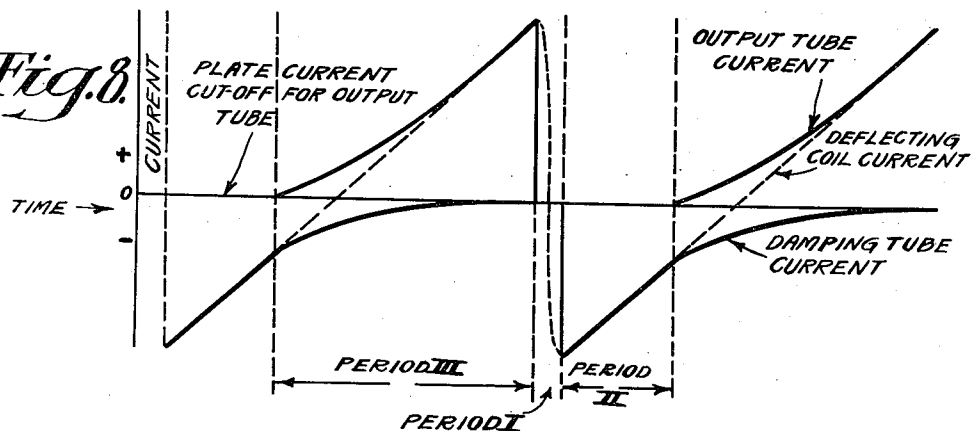


Fig. 8.



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UNITED STATES PATENT OFFICE

2,280,733

DEFLECTING CIRCUITS

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Application June 30, 1939, Serial No. 282,276

5 Claims. (Cl. 250—27)

My invention relates to cathode ray deflecting circuits and particularly to deflecting circuits of the magnetic deflection type in which a so-called damping tube is connected effectively across the deflecting coils.

Circuits of the above-mentioned type are described in Blumlein Patent 2,063,025 and Andrieu Patent 2,139,432. These circuits make it possible to obtain greater deflection at less cost than is possible with circuits which do not employ a damping tube. Heretofore, however, the full possibilities of the damping tube type of deflecting circuits have not been realized because it has not been known how to make the wave form of the current which is passed through the deflecting coils a straight saw-tooth. More specifically, as the deflecting current increases in amplitude beyond a certain value in such prior art circuits, it fails to increase rapidly enough whereby the wave form is that of a saw-tooth which "bends over."

It is accordingly an object of my invention to provide an improved deflecting circuit of the above-mentioned type which produces a deflecting wave having a wave form that is more nearly straight over the useful deflecting portion as distinguished from the return line portion.

It is a further object of my invention to provide an improved magnetic deflection circuit for producing a substantially straight saw-tooth current wave of maximum amplitude.

In practicing my invention I employ a damping tube connected across the deflecting coils and provide means for controlling the impedance of this tube in such a way as to improve the linearity of the saw-tooth wave of current through the deflecting coils. Preferably, the damping tube is a vacuum tube having a control grid, the plate-cathode resistance of the tube being controlled by making the grid more negative in response to an increase in the plate current of an output which feeds current to the deflecting coils. In accordance with one feature of my invention, the control voltage applied to the damping tube grid is substantially independent of the damping tube current.

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

Figures 1 to 5 are circuit diagrams showing several embodiments of my invention, and

Figures 6, 7 and 8 are curves which are referred to in explaining my invention.

Referring to Fig. 1, there is shown the output end of a cathode ray deflecting circuit comprising an output tube 1, a pair of deflecting coils 2

and a damping tube 3. The output tube 1, in the example illustrated, is of the screen grid type having a high plate impedance, but it may be a triode or the like having a lower plate impedance, if desired.

The voltage applied to the control grid of the tube 1 preferably is of a saw-tooth wave form as shown in Fig. 7. It will be noted that this saw-tooth wave "bends over" that is, it is concave downward. It is easier to generate this form of wave than a straight saw-tooth. Also, a satisfactory final adjustment may be made more readily in some instances, if means are provided for changing the curvature of the saw-tooth wave as will be explained hereinafter. The input saw-tooth voltage applied to the tube 1 may be generated as indicated at 5 by any one of several well-known saw-tooth wave generators.

A suitable positive operating voltage may be applied to the plate of the tube 1 through a choke coil 4.

The deflecting coils 2 have their upper terminal connected through a low impedance resistor 6 to the plate of the tube 1 while their lower terminal is connected through an adjustable tap 7 to a point on a potentiometer 8 for centering purposes.

It will be noted that the potentiometer 8 is connected between the positive terminal of the plate voltage supply (not shown) and ground. Since there is a certain D. C. voltage drop in the choke coil 4, the tap 7 may be moved to a point which will result in a direct current flow through the deflecting coils 2 in whichever direction is required for proper centering. Bypass condensers 9 and 11 may be provided.

In accordance with my invention, the damping tube 3 includes a control electrode 12 by means of which the amount of current that passes through the damping tube at a given time in the deflecting cycle may be controlled. The plate-cathode circuit of tube 3 is connected effectively across the deflecting coils 2. In this specific embodiment, it is connected directly across the deflecting coils through a resistor 13 shunted by a condenser 14. The resistor-condenser combination 13—14 is included in the circuit to provide a bias voltage, the time constant of the combination being slow enough to permit only a slight discharge of the condenser 14 between successive deflecting waves. The reason for providing this bias voltage is that the magnitude of the damping tube current may be changed by changing the bias voltage whereby the proper relation of damping

tube current to output tube current may be obtained.

In some circuit designs, it will be found that the biasing combination 13-14 should be omitted in order to lower the impedance of the damping circuit.

The distributed capacity of the deflecting coils 2 is indicated at 16. As will appear from the following description of the circuit operation, the capacity 16 is an important circuit constant.

The action of the circuit of Fig. 1 will first be described with reference to Fig. 6 and with the assumption that the damping tube 3 is a tube such as a diode having no control grid. It will also be assumed that the input voltage on the tube 1 drives it beyond plate current cut-off, as shown in Fig. 7.

Referring to Figs. 6 and 7, the deflecting cycle may be divided into three periods, the first period being the return line period, the second period being the time during the useful deflection period that the output tube is held at plate current cut-off, and the third period being the time that plate current is flowing through the output tube.

First, considering period III, it will be seen that the voltage applied to the grid of the output tube causes the plate current of the output tube 1 to increase as shown by the curve that is concave upward. At the same time, the damping tube (assuming a diode, for example) draws more and more current, the difference between the output tube plate current and the damping tube current being the deflecting coil current. As shown by the dotted line curve, the deflecting coil current does not increase in a straight line curve as desired. Instead, this curve bends over since, as is well understood in the art, the current through an inductive circuit which also contains resistance tends to build up according to a logarithmic law.

The action during the return period I will be considered in two time intervals, the first interval being indicated from *a* to *b* on the deflecting current curve and the second interval being indicated from *b* to *c*.

At point *a*, the output tube current begins to decrease, the output tube being driven to cut-off an instant later. At point *a*, the collapsing flux in the deflecting coils 2 causes the A. C. voltage across them to reverse to make their lower terminal negative and the current flow through the damping tube stops.

During the one-quarter oscillation cycle *a* to *b*, the collapsing flux of the deflecting coils causes the capacity 16 to charge. At point *b*, this charging is completed and from *b* to *c*, the capacity discharges into the deflecting coils. During this time, the flux in the coils 2 is building up and the lower terminal of the coils 2 is still negative whereby no current flows through the damping tube.

At the end of the half oscillation cycle *a* to *c*, the flux in the coils 2 begins to collapse whereby the lower terminal of the coils 2 again goes positive and current flows through the damping tube for the duration of the period II solely as a result of energy previously stored in the deflecting coil-capacity circuit 2-16.

It will be noted that during the period II, current is flowing from the upper terminal of the coils 2 to their lower terminal (and through the damping tube) and that it is decreasing in value. Just before it becomes zero (at the point *d*), the voltage input to the output tube drives the out-

put tube above its cut-off point and plate current starts to flow. This point at which the output tube "takes hold" should be adjusted carefully to avoid a break in the curve representing the deflecting coil current.

It will be apparent that, just after the start of period III, the damping tube current and the output tube current are equal, this being the point where the curve for the deflecting coil current crosses the zero axis. It is important that a flow of plate current through the output tube starts before the deflecting coil current reaches zero. This result may be obtained by varying the curvature in the curve of Fig. 7 representing the input voltage to the output tube, since a change in the curvature will change the time that the output tube is caused to "take hold."

In accordance with the present invention, the bending over of the deflecting current saw-tooth is prevented, as illustrated in Fig. 8, by causing the damping tube to draw less current during the latter part of period III, than in the case illustrated in Fig. 6. As shown in Fig. 8, the deflecting coil current has been made to have a wave form which is a straight saw-tooth by causing the damping tube current to continually decrease in value. It should be understood that the invention is not limited to this specific mode of operation, as the wave shape of the deflecting current is greatly improved if the damping tube current is merely caused to increase less rapidly than in the case illustrated in Fig. 6.

Referring to Fig. 1, the desired control of the diode current is obtained in this particular example of the invention by applying to the damping tube control grid 12 the voltage drop produced across the resistor 6 by the plate current of the output tube 1. Thus, as the plate current of the output tube increases, the grid 12 goes more negative and the plate impedance of the damping tube 3 increases whereby the damping tube draws less current as compared with the current it would draw in the absence of the controlling potential on the grid 12.

It will be seen that it is the total output tube current that flows through the resistor 6 for controlling the damping tube impedance. Since this total current increases more rapidly than in accordance with a straight line, the negative voltage applied to the control grid of the damping tube is such as to make the impedance of this tube increase rapidly enough to produce the desired wave form for the deflecting current.

More specifically, it should be noted that the control obtained by the current flowing through the control resistor 6 is substantially independent of the deflecting coil current, since a change in the output tube current merely causes a change in the damping tube current. It will be evident that this is the case if it is remembered that the damping functions as a voltage regulator to hold the voltage across the deflecting coils substantially constant. Obviously, the wave form and magnitude of the damping tube control voltage can be varied by varying the shape and amplitude of the voltage input to the output tube. Since it is not the deflecting coil current that is controlling the damping tube resistance but, instead, is the output tube current, it is possible to obtain a full linear correction of the deflecting current wave form. In fact, it is possible to over-correct and make the deflecting current saw-tooth actually bend up.

In Figs. 2 to 5 there are shown other embodiments of my invention. In these figures, parts

corresponding to those in Fig. 1 are indicated by like reference numerals. Since all embodiments of the invention operate in substantially the same way as that shown in Fig. 1, their operation will not be discussed in detail. However, the various circuit differences will be pointed out.

Referring to Fig. 2, the deflecting coils 2 are coupled to the output tube through a transformer 21. In this circuit, the damping tube is indicated at 22 as a vacuum tube of the triode type having a control grid 23, the damping tube being connected across the secondary of the transformer 21. The control potential for the grid of the damping tube 22 is obtained from across a plate resistor 24 through which all the output current of the tube 1 flows.

As in the case of the resistor 6 in Fig. 1, the resistor 24 may be adjusted in value to obtain the desired degree of control of the damping tube.

In Fig. 3, parts corresponding to those in Fig. 2 are indicated by the same reference numerals. In this circuit, the damping tube 22 is connected across the primary of the transformer 21, its impedance being controlled by the voltage drop across the resistor 6.

The circuit of Fig. 4 is similar to that of Fig. 2, but in this case the potential of the damping tube cathode is caused to vary to control the damping tube impedance in the desired manner. This control is obtained by utilizing the potential drop in a resistor 26 connected in the cathode circuit of the output tube 1. As in the other embodiments of the invention, both the deflecting coil current and the damping tube current flow through the resistor from which the damping tube control potential is derived.

In Fig. 5, the transformer 21 is employed solely for the purpose of connecting the damping tube 22 effectively across the deflecting coils 2, this making it possible to lower the effective impedance of the damping tube, this being desirable for some circuit designs. The cathode of the damping tube 22 is varied in accordance with the potential drop across the plate circuit resistor 24 to control the damping tube impedance.

The invention has been described for the mode of operation which is referred to as class B since there is a period during which the output tube is at plate current cut-off. The invention also applies to the mode of operation known as class A. In class A operation, the output tube draws plate current throughout the deflection cycle whereby it is less difficult to obtain a straight saw-tooth wave.

The main function of a damping tube during class A operation is to damp out transients in the saw-tooth wave at the end of the return line period. Its function during class B operation is to increase the efficiency of the deflection circuit

as well as to damp out transients. Regardless of the mode of operation, the wave shape of the deflecting current may be improved by utilizing my invention.

I claim as my invention:

1. In combination, a pair of deflecting coils, an output tube having a plate circuit coupled to said coils for supplying deflecting current thereto, a variable impedance device connected effectively across said coils, and means for varying the impedance of said device in accordance with the total alternating current output of said output tube.

2. In combination, a pair of deflecting coils, an output tube having a plate circuit coupled to said coils for supplying deflecting current thereto, a vacuum tube connected effectively across said coils, said vacuum tube having a control grid, and means for applying a control voltage to said control grid which voltage varies in accordance with the sum of the currents passing through said coils and said vacuum tube.

3. In combination, a pair of deflecting coils, an output tube having a control grid and having a plate circuit coupled to said coils for supplying deflecting current thereto, means for applying a periodically recurring voltage to said control grid of such characteristic that a saw-tooth current flows through said coils, a damping tube connected effectively across said coils, and means for periodically increasing the impedance of said damping tube in accordance with the periodic increase in the total alternating current supplied by said output tube.

4. In combination, a pair of deflecting coils, an output tube having a plate circuit coupled to said coils to supply deflecting current thereto, a damping tube coupled effectively across said coils, said damping tube having a control electrode for varying its resistance, a resistor so connected that both the damping tube current and the deflecting coil current flow therethrough, and means for applying the voltage drop across said resistor to said control electrode.

5. In combination, a pair of deflecting coils, an output tube having input electrodes and having a plate circuit coupled to said coils to supply deflecting current thereto, a damping tube connected effectively across said coils, means for applying a periodically recurring voltage to said input electrodes which has a wave shape such as to cause a current flow through said coils having at least approximately a saw-tooth wave shape in the absence of variations in the resistance of said damping tube, and means for increasing the resistance of said damping tube in response to and in accordance with an increase in the total alternating current output of said output tube.

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