

April 17, 1945.

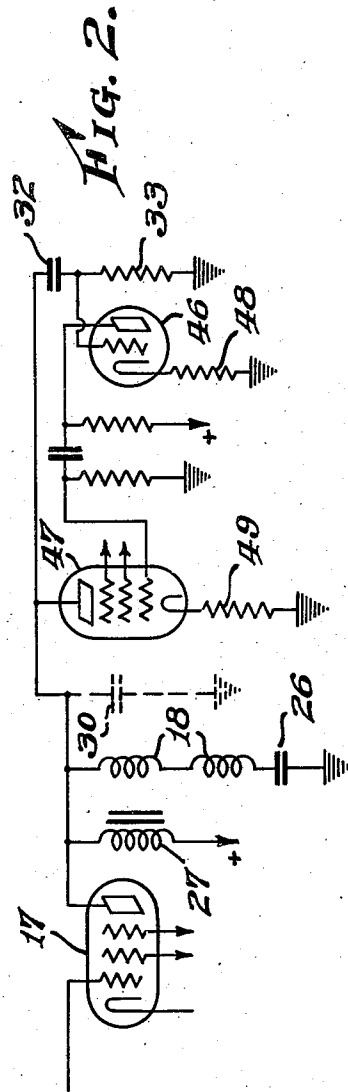
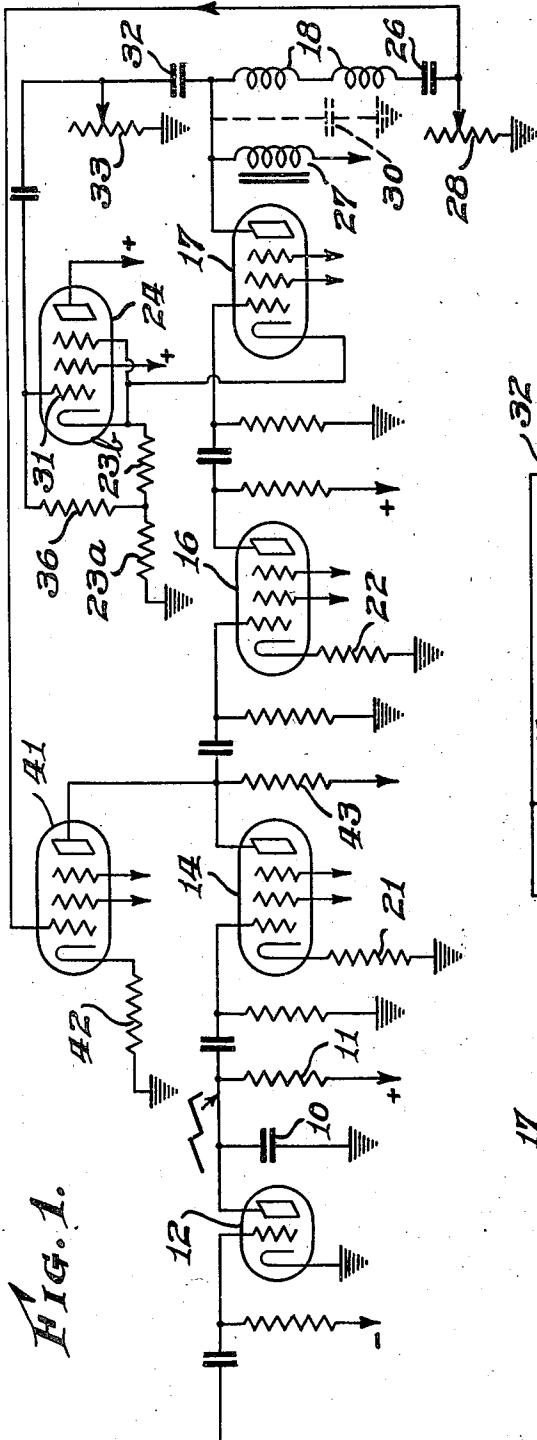
T. T. EATON

2,373,748

DEFLECTING CIRCUIT

Filed Sept. 30, 1941

3 Sheets-Sheet 1



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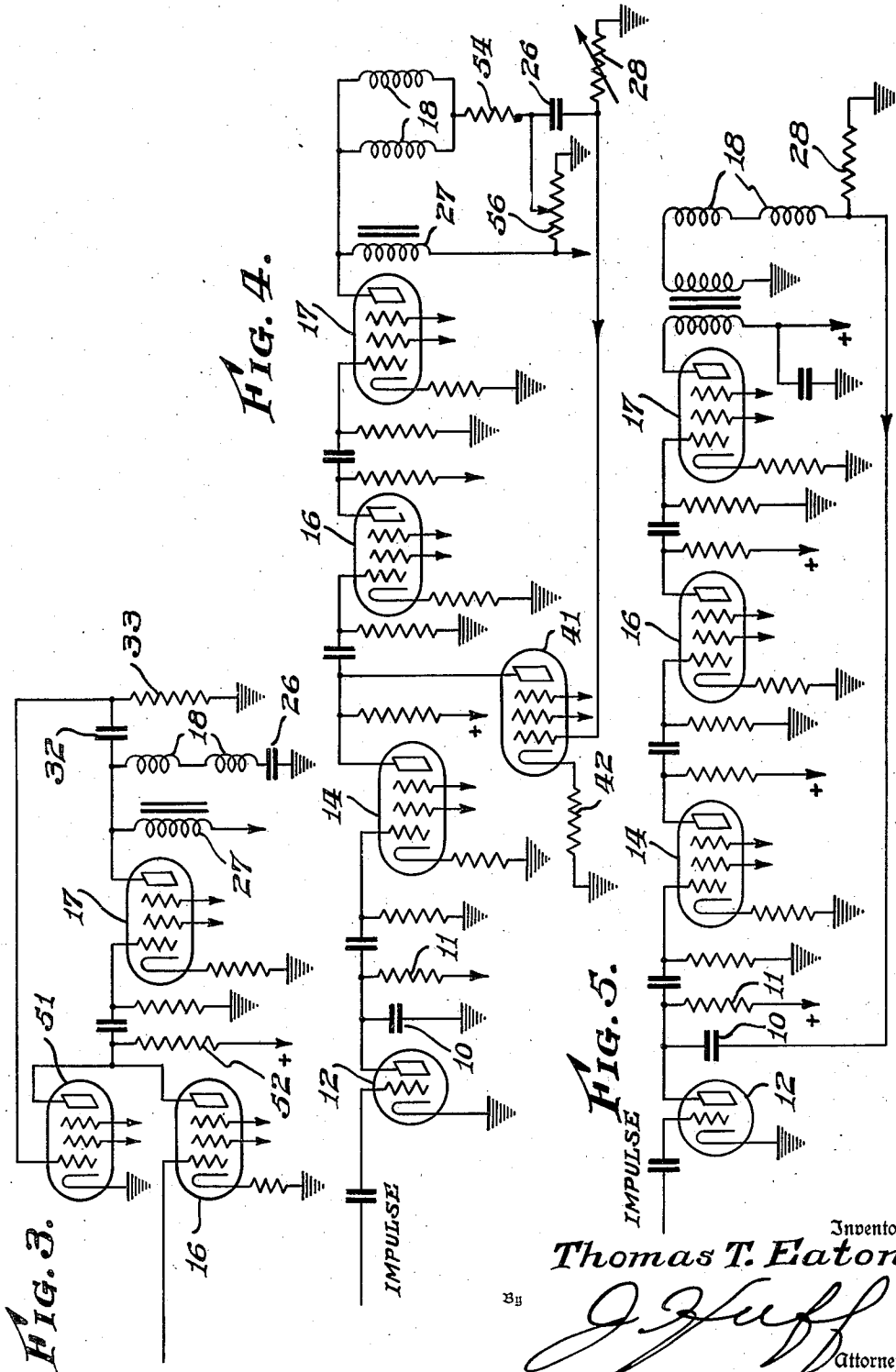
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

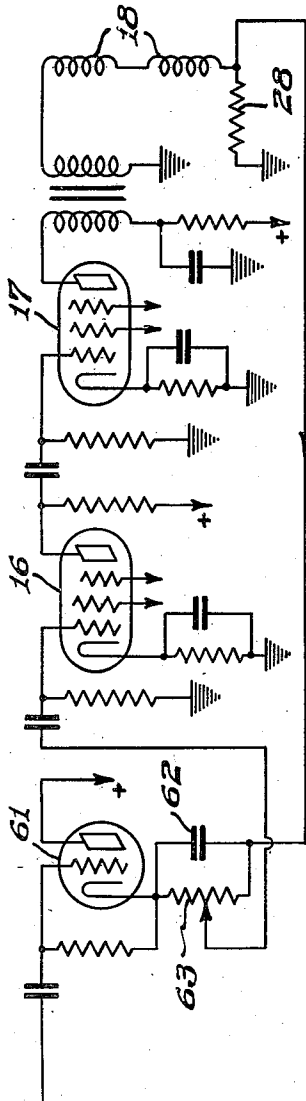


Fig. 6.

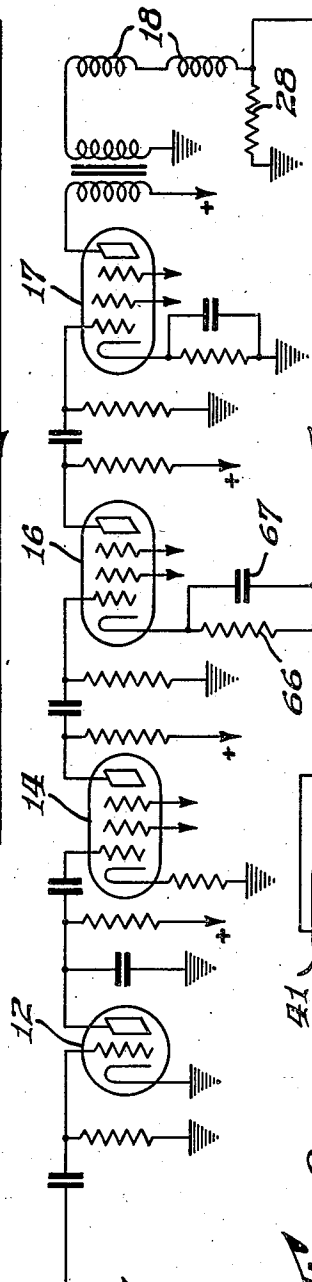


Fig. 7.

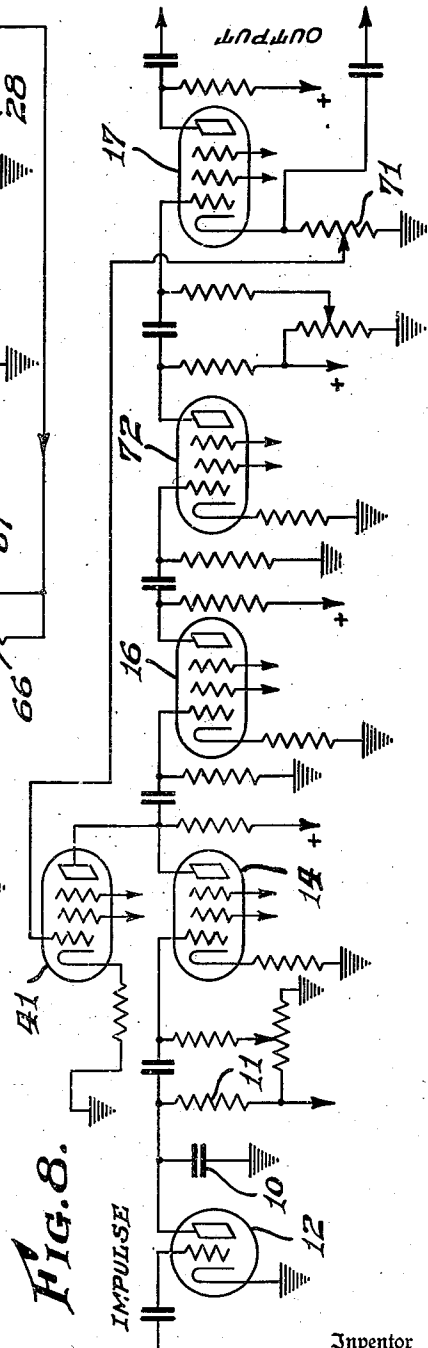


Fig. 8.

IMPULSE

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DEFLECTING CIRCUITS

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4 Claims. (Cl. 175-335)

My invention relates to cathode ray deflecting circuits and particularly to deflecting circuits which produce sawtooth deflecting waves.

An object of the invention is to provide an improved method of and means for causing a flow of deflecting current of the desired wave form through deflecting coils having a substantial amount of distributed capacity.

A further object of the invention is to provide an improved method of and means for reducing or eliminating the effects of distributed capacity or the like across deflecting coils.

A still further object of the invention is to provide an improved method and means for minimizing any distortion of a sawtooth wave introduced by amplifier tubes or other parts of a channel through which the sawtooth wave is passed.

In one embodiment of the invention as applied to the horizontal deflection circuit of a television receiver, for example, the distributed capacity of the deflecting coils is made ineffective in the circuit by connecting a negative capacity circuit to the deflecting coils. This negative capacity can be made to cancel out any undesired capacity across the deflecting coils. In this way I avoid the necessity of employing a damping tube or the like across the deflecting coils to reduce the transient otherwise caused at the end of each deflection by the distributed capacity.

Since my horizontal deflecting circuit contains no damping tube it is now possible to utilize a negative feedback circuit to remove any wave form distortion that may be introduced in the circuit following the sawtooth generator or other point where the wave has the desired wave form. The voltage that is fed back preferably is taken from across a resistor connected in series with the deflecting coils.

In other embodiments of the invention, the negative capacity network is employed to improve the deflection circuit operation without employing a negative feedback circuit in combination with it.

In still other embodiments of the invention, especially as applied to vertical deflecting circuits, negative feedback circuits are employed without the use of negative capacity circuits.

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

Fig. 1 is a circuit diagram of an embodiment of my invention as applied to the horizontal deflecting circuit of a television receiver,

Figs. 2 and 3 are circuit diagrams showing other embodiments of the invention utilizing negative

capacity networks for cancelling deflecting coil capacity in horizontal deflecting circuits.

Figs. 4 to 7 show embodiments of the invention wherein negative feedback is utilized in electromagnetic vertical deflecting circuits to minimize wave form distortion, and

Fig. 8 shows the use of negative feedback in an electrostatic deflection circuit to minimize wave form distortion.

In the several figures like parts are indicated by the same reference characters.

Referring to Fig. 1, the circuit comprises a condenser 10 which is charged slowly through a resistor 11 and then discharged rapidly through a discharge tube 12 in response to the application of a pulse on the grid of the tube whereby a sawtooth voltage wave appears across the condenser.

The sawtooth voltage wave is amplified by resistance coupled amplifiers 14 and 16 and applied to the control grid of a pentode 17 which functions as the output tube supplying sawtooth current to a pair of deflecting coils 18.

Amplifier tubes 14 and 16 may be suitably biased by means of cathode resistors 21 and 22, respectively, to function as linear amplifiers. Output tube 17 is also biased to function as a class A amplifier, the bias being provided by a cathode resistor 23a-23b which is common to the tube 17 and to a vacuum tube 24 described below.

The deflecting coils 18 have condenser 26 in series therewith to block the D.-C. component, the plate voltage for tube 17 being applied through a choke coil 27.

A resistor 28 is also connected in series with the deflecting coils in order to obtain a feedback voltage having the same wave shape as the deflecting current as will be described hereinafter.

The circuit so far described may not be very satisfactory if the deflection is to occur at a comparatively high frequency such as 13,290 per second commonly employed for the horizontal deflection in a television system. The main reason for this is the presence of capacity across the deflecting coils 18 which is indicated at 30. This is mainly the distributed capacity of the coils, but it also includes any other capacity across the coils such as tube capacity.

A well known way of reducing or eliminating transients caused by the capacity 30 is to connect a damping tube across the deflecting coils. If this is done, however, the feedback correction circuit described hereinafter cannot be employed since a substantial amount of the output tube current goes into the damping circuit.

The negative capacity network, which will now be described, makes possible the use of the feedback correction in a horizontal deflecting circuit or the like having a large amount of distributed capacity.

The negative capacity network comprises the vacuum tube 24, which is shown by way of example as a pentode, having its control grid 31 connected to a phase shifting circuit consisting of a condenser 32 and a low resistance resistor 33 connected in series with each other between the plate of output tube 17 and ground. A suitable negative bias is maintained on the grid 31 by a grid leak connection 36 to a point on the cathode resistor 23a—23b whereby the tube 24 operates over a substantially linear part of its characteristic. The usual positive operating voltages are applied to the plate and screen grid of tube 24.

The basic operation of the negative capacity network is similar to that of the well known reactance tube circuits employed for automatic frequency control and for frequency modulation. Specifically, plate current from the tube 17 passes through the phase shifting circuit 32—33 whereby a voltage appears across the resistor 33 which leads the voltage at the plate of tube 17 by substantially 90°. It is this leading voltage that is applied to the grid 31. The plate current of the tube 24 will be in phase with the said voltage on its grid whereby this plate current and the corresponding voltage drop in cathode resistor 25a—23b also lead by substantially 90° the voltage at the plate of tube 17.

Since the voltage drop in cathode resistor 23a—23b is applied to the cathode of tube 17, the current component produced by it in the plate circuit is reversed in phase. Thus, the 90° leading voltage at the cathode of tube 17 produces a 90° lagging plate current component, it being assumed that the plate circuit is resistive. This is a proper assumption since the plate-cathode impedance of a pentode is very high compared with the impedance of the deflecting coils.

From the foregoing it will be apparent that by properly adjusting the tap on the phase shift resistor 33, the magnitude of the above-described 90° lagging current component can be made equal to the 90° leading current component caused by the distributed capacity 30. In other words, I have introduced a negative capacity that balances out the capacity 30.

A negative feedback circuit may now be utilized to make the deflecting current in coils 18 have the same wave shape as the wave shape of the voltage appearing on the plate of amplifier tube 14. It will be understood that while a voltage having a good sawtooth shape may be produced without much difficulty, it generally has been difficult to make the final deflecting current have exactly the same shape. For example, the characteristics of the amplifier tubes 16 and 17 may depart enough from linearity to introduce distortion.

In the example shown in Fig. 1, the voltage across the low impedance resistor 28 is fed back to an amplifier tube 41 which is biased by a cathode resistor 42 to function as a linear amplifier. The tube 41 and the tube 14 have a common plate resistor 43 whereby their outputs add algebraically. Since these outputs are 180° out of phase any departure from the desired wave shape of the deflecting current will cause a correcting voltage component to be applied to the amplifier tube 16. The degenerative action will

bring the deflecting current wave shape very close to the wave shape of the input voltage, the exactness of the correction depending upon the gain in the feedback loop.

Fig. 2 shows another circuit that may be utilized for obtaining the desired negative capacity. A 90° shifting network 32—33 is connected from the plate of the output tube 17 to ground as in Fig. 1. The leading voltage appearing across resistor 33 is amplified by an amplifier tube 46 and applied to the control grid of a pentode 47. The plate of pentode 47 is connected to the plate of the output tube 17 whereby a 90° lagging current is supplied to balance out the 90° leading current taken by the distributed capacity 30. The cathode resistors 48 and 49 are provided to bias the tubes 46 and 47, respectively.

Fig. 3 shows another example of negative capacity circuits that may be employed in practicing the invention. Here the leading voltage across resistor 33 is applied to an amplifier tube 51. The plate resistor 52 is common to the amplifiers 51 and 16 whereby the reactive voltage component is added to the sawtooth voltage supplied through the tube 16. Thus the desired 90° lagging current component appears in the plate circuit of the tube 17.

Fig. 4 shows a negative feedback circuit for reducing sawtooth wave distortion in a vertical deflecting circuit which does not require any special circuit for eliminating distributed capacity effects.

Since the various elements for this circuit are substantially the same as in the horizontal deflecting circuit except for the circuit constants, corresponding parts are indicated by the same reference numerals.

The deflecting coil current passes through the coils 18 in parallel, through a resistor 54 which may be provided to help in obtaining a straight sawtooth shape, and through the blocking condenser 26 and the resistor 28. The lower end of resistor 54 may be connected to a voltage divider 56 through a variable tap for centering purposes.

As in the circuit of Fig. 1, the voltage drop across resistor 28 is fed back to an amplifier tube 41 which introduces negative feedback at the input circuit of amplifier 16 to remove distortion introduced by amplifiers 16 and 17, and by distributed capacity, etc., in the output circuit of the tube 17.

Fig. 5 shows a vertical deflecting circuit in which the negative feedback voltage from resistor 28 is inserted directly into the sawtooth generator 10—11—12. It will be noted that the condenser 10 is connected through resistor 28 to ground whereby the voltage across resistor 28 is added algebraically to the desired straight sawtooth produced across condenser 10.

Fig. 6 shows a vertical deflecting circuit similar to that of Fig. 5 in that the negative feedback resistor 28 is included in the sawtooth generator itself. The said generator comprises a vacuum tube 61 having a condenser 62 connected between the cathode of tube 61 and ground and in series with resistor 28. The condenser 62 is charged through the tube 61 upon reception of a positive pulse and is discharged comparatively slowly through the shunting resistor 63. Since the resulting sawtooth voltage across condenser 62 is of reversed polarity as compared with that produced in the other sawtooth generating circuits, one amplifier stage may be omitted and the feedback voltage will be the correct polarity.

Fig. 7 shows a circuit in which the feedback

voltage is fed into the cathode circuit of the amplifier tube 16, the resistor 28 being in series with the cathode biasing resistor 66 which is bypassed by a condenser 67.

Fig. 8 shows an electrostatic deflection circuit for applying sawtooth voltage waves to deflecting plates (not shown). The circuit is similar to that shown in Fig. 4, the main difference being that the sawtooth voltage for the negative feedback circuit is taken off a resistor 71 in the cathode circuit of tube 17. Also, an additional amplifier stage 72 is employed to obtain the correct feedback polarity. It will be noted that sawtooth voltages of opposite polarity are obtained from the plate and cathode circuits of tube 17 to apply the deflecting voltages in balanced relation to the deflecting plates (not shown). It will be apparent that any departure from the desired voltage wave form in the said plate and cathode circuits will be corrected by the negative feedback.

I claim as my invention:

1. A horizontal deflecting circuit comprising a pair of deflecting coils having undesired distributed capacity thereacross, means for producing a voltage having a certain wave form, an amplifier tube having a plate circuit coupled to said coils and having an input circuit coupled to said voltage producing means, means comprising a negative capacity network of the reactance tube type for cancelling out at least a substantial part of said distributed capacity, means for obtaining a voltage having the same wave shape as that of the current flowing through said coils, and a negative feedback circuit for feeding back said second voltage to a point where said first voltage appears for reducing distortion in the wave shape of said current.

2. An electromagnetic deflecting circuit comprising a pair of deflecting coils having undesired distributed capacity thereacross, a vacuum tube

connected to supply plate current to said coils, a phase shifting network connected across said coils to produce a voltage having a reactive component, an amplifier tube having an input circuit to which said voltage is applied, and means for so connecting the output circuit of said amplifier tube to said deflecting circuit that there is produced in said coils a lagging current component to cancel the leading current component caused by said distributed capacity.

3. An electromagnetic deflecting circuit comprising a pair of deflecting coils having undesired distributed capacity thereacross, means for obtaining a voltage having a reactive component 90 degrees out of phase with respect to the voltage across said coils, and means including an amplifier upon which said reactive component is impressed for supplying to said coils a lagging current to cancel at least part of the leading current caused by said distributed capacity.

4. An electromagnetic deflecting circuit comprising a pair of deflecting coils having undesired capacity thereacross, a vacuum tube connected to supply plate current to said coils, a phase shifting network connected across said coils to produce a voltage having a reactive component, an amplifier tube having an input circuit to which said voltage is applied, means for so connecting the output circuit of said amplifier tube to said deflecting circuit that there is produced in said coils a lagging current component to cancel the leading current component caused by said distributed capacity, means comprising a low resistance resistor in series with said deflecting coils for obtaining a voltage having the same wave shape as that of the current flowing through said coils, and means comprising a negative feedback circuit for feeding back said voltage to reduce distortion in the wave shape of said deflecting coil current.

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