

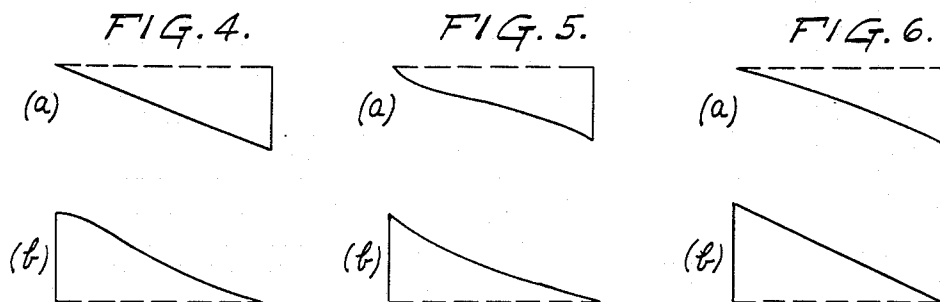
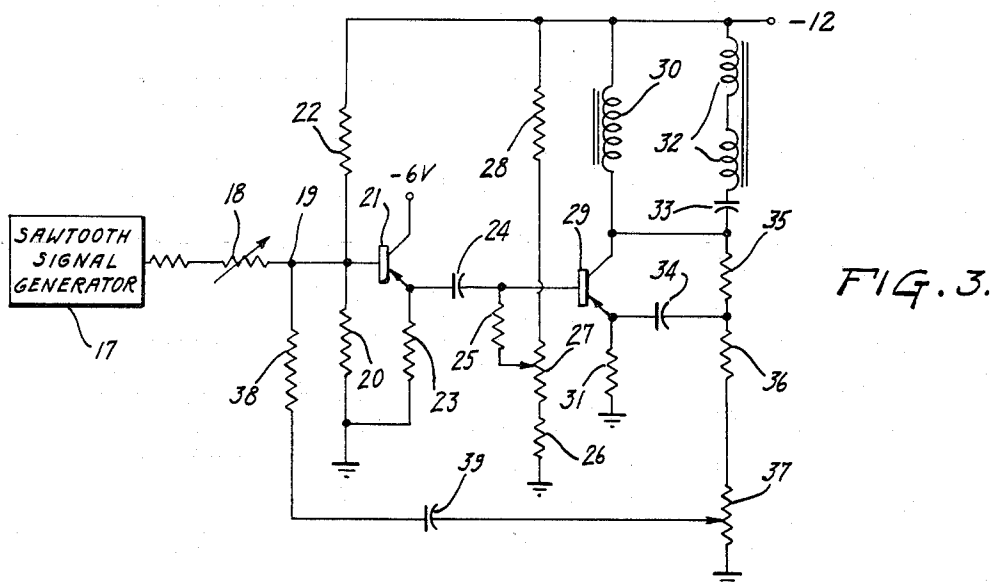
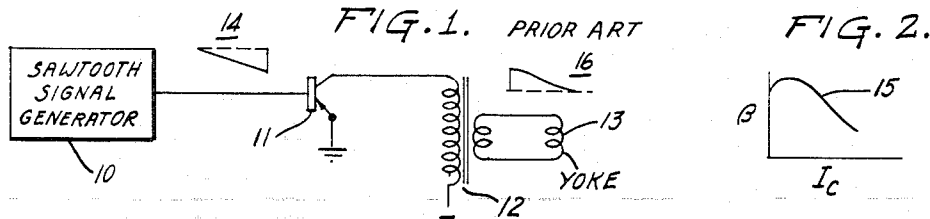
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DEFLECTION SYSTEM FOR CATHODE RAY TUBES

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DEFLECTION SYSTEM FOR CATHODE RAY TUBES

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This invention relates to deflection systems for cathode ray tubes, and more particularly to deflection systems employing a transistor in the output stage.

While not limited thereto, the invention is applicable to the vertical deflection system of a television receiver and it will be described with reference to such application.

In operation of a cathode ray tube, it is usually desirable to effect deflection of the electron beam in a given direction with constant velocity during each scan interval. This requires the production of a deflection waveform which is linear during each scan interval. The deflection waveform is produced in response to a driving signal of sawtooth form which preferably is linear during each scan interval. However, even though the driving signal may have this desired characteristic, non-linearity tends to be introduced into the deflection waveform due to the non-linear transfer characteristic of the coupling means through which the deflection waveform is supplied to the deflecting means associated with the cathode ray tube.

In the case of a deflection system employing a vacuum tube as the output device, the inherent transfer characteristic of the vacuum tube is such as to help compensate for the non-linearity. However, in the case of a deflection system employing a transistor as the output device operating in the same manner as a vacuum tube, the inherent transfer characteristic of the transistor is such as to increase the non-linearity. This has posed a serious problem, particularly in view of the fact that the transistor has well-recognized advantages over the vacuum tube.

One object of the present invention is to provide a satisfactory solution of this problem.

A more specific object of the invention is to provide an improved deflection system wherein the aforementioned objection is overcome by effecting compensation for the non-linearities introduced by the transistor and the coupling means.

In accordance with this invention, the desired compensation is effected in such a system by the provision of an arrangement whereby the driving signal is modified to such form as to compensate for the non-linearities and produce a linear deflection waveform. More particularly, this invention provides an arrangement comprising a frequency-responsive network and degenerative feedback means which cooperatively effect the desired modification of the driving signal. By proper adjustment of the amount of feedback, the driving signal may be modified to the correct form for exact compensation.

The invention may be fully understood from the following detailed description with reference to the accompanying drawing, wherein

Fig. 1 is a simple diagrammatic illustration of a vertical deflection system employing a transistor in conventional manner;

Fig. 2 shows generally the beta characteristic of the transistor.

Fig. 3 is a schematic diagram of a vertical deflection system which embodies this invention and which has been successfully employed in a television receiver; and

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Figs. 4 to 6 illustrate various waveforms to facilitate an understanding of the invention.

Referring first to Fig. 1, there is shown in simple form a vertical deflection system comprising a sawtooth signal generator 10, a transistor 11 which may be assumed to be of the p-n-p junction type, an output transformer 12, and vertical deflection means represented as a single coil 13 which forms part of the deflection yoke associated with the cathode ray tube. In operation, the driving signal, represented at 14, initiates minimum conduction of the transistor at the beginning of each scan interval and renders the transistor increasingly conductive until the end of the scan interval when retrace occurs. Due to the beta characteristic of the transistor, which is generally of the form shown at 15 in Fig. 2, and also due to the drooping characteristic of the coupling means 12, the deflection current in coil 13 is caused to be non-linear, as represented at 16.

Referring now to Fig. 3, there is shown a vertical deflection system embodying the present invention which effects compensation for the non-linearities of the output transistor and the coupling means. In the preferred form illustrated, the driving signal is supplied from the sawtooth signal generator 17 through height control resistor 18 to point 19 and appears across input resistor 20 of a driving transistor 21 which is connected as an emitter follower. The voltage divider constituted by resistors 20 and 22 provides a bias voltage across resistor 20 between the base and emitter of transistor 21. The signal appearing across resistor 23 is supplied through coupling capacitor 24 across resistors 25 and 26, and the portion of resistor 27 below the adjustable tap. The voltage divider constituted by resistors 26, 27 and 28 provides a bias voltage across resistor 26 and the said portion of resistor 27. The collector current of the output transistor 29 flows through coupling choke 30 and resistor 31, and the deflection voltage across the choke 30 is applied across the deflection coils 32 and series capacitor 33 to produce deflection current in the coils.

As thus far described the system is of known form. The transistors may be assumed to be of the p-n-p junction type. Both the output transistor 29 and the coupling means 30 have non-linear transfer characteristics which cumulatively tend to introduce non-linearity into the deflection waveform.

In accordance with the present invention, this objection is overcome by providing the arrangement comprising elements 34 to 39 connected as shown. The manner in which this arrangement effects compensation for the non-linearities and produces a linear deflection waveform will now be described with reference to the waveforms illustrated in Figs. 4 to 6 which were traced from photographs of waveforms on an oscilloscope.

Referring first to Fig. 4, there are shown respectively at (a) and (b) the driving signal at point 19 (Fig. 3) and the deflection current in coils 32 in the absence of the arrangement provided by this invention, one cycle being sufficient to show the waveform in each instance. It will be noted that the driving signal is linear and the deflection current is non-linear.

Now with reference to the arrangement provided by this invention, consider first the R-C combination comprising resistor 38 and capacitor 39, and assume that the adjustable tap of potentiometer 37 is in its lowermost position. This series R-C combination is connected between point 19 and ground, and it has a short time constant relative to the time duration of each cycle of the driving signal. It comprises a frequency-responsive high-pass series network connected across the input of transistor 21.

During each scan or sweep portion of the driving signal, the charging current of capacitor 39 flows through

resistors 18 and 38, reducing the available voltage at the base of transistor 21. As the scan progresses, capacitor 39 draws less current, allowing the potential at the base of transistor 21 to increase. The result is that the driving signal is transformed to the waveform shown at (a) in Fig. 5. This waveform tends to compensate for the non-linearities of transistor 29 and coupling means 30 but it is not entirely satisfactory because it is non-linear during the first part of the scan. With this waveform of the driving signal, the deflection current has the waveform shown at (b) in Fig. 5 which, while linear during the latter part of the scan, is non-linear during the first part of the scan. It was found to be impossible fully to correct the waveform by means of the frequency-responsive network alone. However full correction was achieved by the incorporation of feedback action as now to be described.

It was found that the desired correction could be achieved by integrating the voltage at the collector of transistor 29, deriving the proper amount of the integrated voltage, subjecting it to a differentiating action, and applying the resultant voltage at point 19.

Thus in the illustrated system, the voltage at the collector of the output transistor 29 is integrated by capacitor 34 and resistor 35, and a controllable portion of the integrated voltage is fed from potentiometer 37 through the R-C network 38, 39 to point 19. By proper adjustment of potentiometer 37, the waveform of the deflection current in the deflection coils 32 is caused to be linear.

Fig. 6 shows at (a) the correctly modified driving signal and at (b) the linearized deflection current. It will be noted from Fig. 6 (a) that the feedback arrangement serves to correct the driving signal of Fig. 5 (a) which is obtained by the use of the R-C network 38, 39 alone.

From the foregoing description, it will be seen that two cooperative actions are performed by the arrangement provided by this invention, and it will also be seen that in the preferred embodiment, the R-C network including resistor 38 and capacitor 39 plays a dual role. One action is that performed by the R-C network as a frequency-responsive network, in which role it tends to modify the driving signal to the waveform of Fig. 5 (a). The other action is that performed by the feedback arrangement as a whole in further modifying the driving signal to the waveform of Fig. 6 (a), in which action the R-C network plays the role of a differentiating means. The over-all result of both actions is to effect compensation for the non-linearities of transistor 29 and coupling means 30 so as to impart linearity to the deflection current waveform, as in Fig. 6 (b).

In a physical embodiment of the illustrated system, the circuit parameters were as follows, it being understood that these are merely exemplary.

Resistor 19	10K
Resistor 20	12K
Transistor 21	2N224
Resistor 22	82K
Resistor 23	1K
Capacitor 24	500 mf.
Resistor 25	1K
Resistor 26	560 ohms
Potentiometer 27	1K
Resistor 28	8.2K
Transistor 29	2N352
Choke 30	1 h., 40 ohms
Resistor 31	1 ohm
Coils 32	40 mh., 40 ohms
Capacitor 33	500 mf.
Capacitor 34	2 mf.
Resistor 35	4.7K
Resistor 36	2.7K
Potentiometer 37	2.5K
Resistor 38	18K
Capacitor 39	0.39 mf.

While a preferred embodiment of the invention has been illustrated and described, it is to be understood that the invention is not limited thereto but contemplates such modifications and further embodiments as may occur to those skilled in the art.

We claim:

1. In a deflection system for a cathode ray tube, deflection means to which it is desired to supply a deflection waveform which is linear during each scan interval, a source of a driving signal of sawtooth form, circuit means including at least one transistor connected to said source for supplying a deflection waveform to said deflection means in response to said driving signal, said circuit means having inherent non-linear response tending to introduce undesirable non-linearity into the deflection waveform, and a feedback arrangement extending from the output of said circuit means to the input thereof and including integrating means for effecting modification of the waveform of said driving signal so as to compensate for the non-linear response of said circuit means and thus linearize the deflection waveform.

2. A deflection system according to claim 1, wherein said feedback arrangement for effecting modification of the waveform of said driving signal comprises a frequency-responsive network connected across the input of said circuit means, and feedback means for supplying a corrective voltage from the output of said circuit means through said network to the input of said circuit means.

3. A deflection system according to claim 2, wherein said network comprises series-connected resistance and capacitance elements, and said feedback means comprises integrating means.

4. In a deflection system for a cathode ray tube, deflection means to which it is desired to supply a deflection waveform which is linear during each scan interval, a source of a driving signal of sawtooth form, circuit means connected to said source for supplying a deflection waveform to said deflection means in response to said driving signal, said circuit means including an output transistor having a collector-emitter output circuit, said circuit means having inherent non-linear response tending to introduce undesirable non-linearity into the deflection waveform, a frequency-responsive resistance-capacitance network connected across the input of said circuit means for effecting modification of the waveform of said driving signal tending to linearize the deflection waveform, resistance means connected between the collector of said transistor and a point of fixed potential, a capacitor connected between the emitter of said transistor and an intermediate point of said resistance means, said capacitor and the portion of said resistance means between said collector and said intermediate point constituting an integrating means, and a connection extending from a point on said resistance means intermediate the aforementioned points to said resistance-capacitance network, whereby the driving signal is further modified so as to linearize the deflection waveform.

5. In a deflection system for a cathode ray tube, deflection means to which it is desired to supply a deflection waveform which is linear during each scan interval, a source of a driving signal of sawtooth form, circuit means connected to said source for supplying a deflection waveform to said deflection means in response to said driving signal, said circuit means including an output transistor having a collector-emitter output circuit, said circuit means having inherent non-linear response tending to introduce undesirable non-linearity into the deflection waveform, a frequency-responsive resistance-capacitance network connected across the input of said circuit means for effecting modification of the waveform of said driving signal tending to linearize the deflection waveform, two resistors and a potentiometer serially connected across said output circuit, a capacitor connected between the emitter of said transistor and a point intermediate said resistors, one of said resistors

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and said capacitor constituting an integrating means, and means connecting the movable contact of said potentiometer to said resistance-capacitance network, whereby with proper adjustment of said potentiometer the driving signal is further modified so as to linearize the deflection waveform.

6. In a deflection system for a cathode ray tube, deflection means to which it is desired to supply a deflection waveform which is linear during each scan interval, a source of a driving signal of sawtooth form, circuit means connected to said source for supplying a deflection waveform to said deflection means in response to said driving signal, said circuit means including an input transistor connected as an emitter follower and an output transistor having a collector-emitter output circuit, said circuit means having inherent non-linear response tending to introduce undesirable non-linearity into the deflection waveform, a frequency-responsive resistance-capacitance network connected across the input of said emitter-follower transistor for effecting modification of the waveform of said driving signal tending to linearize the deflection waveform, and a feedback arrangement extending from the output circuit of said output transistor to the input of said emitter-follower transistor for effecting further modification of the driving signal so as to linearize the deflection waveform.

7. In a deflection system for a cathode ray tube, deflection means to which it is desired to supply a deflection waveform which is linear during each scan interval, a source of a driving signal of sawtooth form, circuit means connected to said source for supplying a deflection waveform to said deflection means in response to said driving signal, said circuit means including an input transistor connected as an emitter follower and an output

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transistor having a collector-emitter output circuit, said circuit means having inherent non-linear response tending to introduce undesirable non-linearity into the deflection waveform, a frequency-responsive resistance-capacitance network connected across the input of said circuit means for effecting modification of the waveform of said driving signal tending to linearize the deflection waveform, two resistors and a potentiometer serially connected across said output circuit, a capacitor connected between the emitter of said output transistor and a point intermediate said resistors, one of said resistors and said capacitor constituting integrating means, and means connecting the movable contact of said potentiometer to said resistance-capacitance network, whereby with proper adjustment of said potentiometer the driving signal is further modified so as to linearize the deflection waveform.

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