

PARABOLIC VOLTAGE GENERATING CIRCUIT

The invention relates to a circuit that generates a parabolic waveform at a frequency related to a deflection frequency, as is a feature of certain display devices in which electron beams in a picture tube are deflected by magnetic fields generated by sawtooth deflection currents flowing in horizontal (line) and vertical (field) deflection windings. The deflected electron beams scan a raster pattern on the picture tube phosphor screen. The raster pattern, without correction, may display various geometric distortions such as side or east-west pincushion distortion and top and bottom or north-south pincushion distortion.

To correct, for example, side pincushion distortion, the horizontal deflection trace current in the horizontal deflection winding may be modulated at a vertical rate in a parabolic manner. Such parabolic modulation may be accomplished by a modulator circuit, coupled to the horizontal deflection circuit output stage.

In a typical horizontal deflection circuit output stage, a deflection trace capacitor is coupled to a deflection winding. The trace capacitor is charged from a B+ operating voltage supply through a flyback transformer primary winding. A deflection switch is provided in order to generate horizontal rate sawtooth current in the deflection winding. During horizontal retrace, the horizontal deflection winding resonates with a retrace capacitor for providing flyback of the sawtooth current.

A well known way of modulating the trace current at a vertical rate in a parabolic manner is summing a vertical rate voltage that is substantially parabolic with a DC voltage to provide the B+ operating voltage for the horizontal deflection output stage. In such an arrangement, the B+ operating voltage includes a vertical rate substantially parabolic component voltage and a DC component voltage. At the vertical center of the raster, the B+ operating voltage is at a maximum; whereas at the

top and bottom, it is at a minimum. As a result, the trace voltage across the trace capacitor varies in a parabolic manner, thereby providing side pincushion correction.

5 A television receiver may be provided with, for example, an adjustable resistor for controlling the amplitude of the horizontal deflection current. This adjustable resistor is generally referred to as the width control. Raster width adjustment is accomplished using
10 the width control to obtain the required amplitude of the deflection current. In the arrangement that was discussed above, the width control may control the raster width by controlling the DC component voltage of the B+ operating voltage.

15 Another adjustment that may be included in a television receiver is the adjustment of the amplitude of a parabolic voltage that provides pincushion distortion correction, such as discussed above. The extent of, for example, east-west modulation is determined by the
20 peak-to-peak amplitude of the substantially parabolic component voltage that is part of the B+ operating voltage. The width of the raster is determined by the level of the B+ operating voltage at the vertical center of the screen. The maximum level of the parabolic
25 component voltage that occurs at the vertical center determines the width of the raster.

 In accordance with a feature of the invention, in order to simplify the adjustment of the width of the raster and the pincushion distortion correction, provision
30 may be made to vary or adjust the peak-to-peak amplitude of the parabolic component voltage for obtaining the required pincushion distortion correction without affecting, by such adjustment, the raster width. In this way, there is no need to readjust the width control after
35 adjusting the parabolic component voltage that provides pincushion distortion correction.

In carrying out an aspect of the invention, the peak level of the B+ operating voltage that occurs at the vertical center is automatically maintained constant when the peak-to-peak amplitude of the parabolic component voltage thereof is adjusted to obtain pincushion distortion correction.

In accordance with an aspect of the invention, a television apparatus generates a periodic parabolic voltage having a period that is related to a deflection frequency. A source of a reference voltage is provided. A control signal is generated in accordance with the difference between the parabolic and reference voltages. The control signal maintains the level of the parabolic voltage that occurs during a predetermined portion of the period of the parabolic voltage, at a level that is determined by the reference voltage. When a change in the amplitude of the parabolic voltage occurs, such as, for example, in the peak-to-peak amplitude of the parabolic voltage, the control signal automatically maintains the parabolic voltage that occurs during the predetermined portion of the period at the same level.

In carrying out another aspect of the invention, the parabolic voltage is at a vertical rate and has an adjustable peak-to-peak amplitude that provides raster distortion correction. After adjusting the peak-to-peak amplitude of the parabolic voltage, the control signal automatically maintains the minimum level of the parabolic voltage in each vertical period at substantially the same level in accordance with the level of the reference voltage. In this way, the control signal maintains the raster width unchanged.

In carrying out yet another aspect of the invention, the parabolic voltage is applied to a source that generates therefrom the B+ operating voltage for forming a substantially parabolic voltage component of the B+ operating voltage. The B+ operating voltage is coupled to a deflection circuit output stage for varying the amplitude of the trace current in a deflection winding in

a parabolic manner to obtain pincushion distortion correction. The instantaneous level of the parabolic component voltage of the B+ operating voltage is determined by the instantaneous level of the waveform of the parabolic voltage. In each vertical period, the maximum level of the B+ operating voltage occurs when the minimum level of the parabolic voltage occurs. By automatically maintaining the minimum level of the parabolic voltage at the same level when the peak-to-peak amplitude of the parabolic voltage varies or is adjusted, the maximum level of the B+ operating voltage is automatically maintained at the same level. Thus, the maximum level of the B+ operating voltage is independent of the peak-to-peak amplitude of the adjustable parabolic voltage component. Therefore, at the vertical center of the raster, the amplitude of the horizontal trace current is the same irrespective of the amplitude of the adjustable parabolic component voltage. The width of the raster will remain unchanged after the peak-to-peak amplitude of the parabolic component voltage is adjusted.

In the Drawing:

FIGURE 1 illustrates a parabolic waveform generating circuit, embodying the invention, that provides east-west correction in a deflection circuit output stage; and

FIGURES 2a-2c illustrate waveforms useful in explaining the operation of the circuit of FIGURE 1.

FIGURE 1 illustrates a horizontal deflection circuit 122 including a modulating circuit 200 that provides side pincushion distortion correction by modulating, at a vertical rate in a parabolic manner, a horizontal deflection current i_y in horizontal deflection circuit 122. Conventionally designed horizontal deflection circuit 122 includes a deflection trace capacitor C_s that is coupled to a horizontal deflection winding L_h . Trace capacitor C_s is charged from a B+ operating voltage that is produced by a power supply 40 of modulator circuit 200.

The B+ operating voltage is coupled to a terminal 27 of a primary winding T1a of a flyback transformer T1 of deflection circuit 122. A deflection switch transistor Q1 is provided in order to generate horizontal rate sawtooth current i_Y in deflection winding L_Y . During horizontal retrace, horizontal deflection winding L_Y resonates with a retrace capacitor C_R for providing flyback of the sawtooth current i_Y . Deflection switch Q1 is controlled by a horizontal oscillator and driver unit 120 that is conventionally designed. The instantaneous value of the B+ operating voltage is controlled, in power supply 40, by an input signal V_{IN} . The operation of supply 40 is such that the B+ operating voltage is equal to input voltage V_{IN} multiplied by, illustratively, a substantially constant positive factor K. Power supply 40 is conventionally designed. It may include a switched mode power supply using pulse width modulation principles, or a series pass transistor operated in a Class A mode.

Modulating circuit 200 controls deflection current i_Y in deflection winding L_Y by controlling the instantaneous level of signal V_{IN} that controls the instantaneous level of the B+ operating voltage. Modulating circuit 200 causes deflection current i_Y , having a sawtooth waveform, to have a peak-to-peak amplitude that is directly proportional in each horizontal period to the algebraic sum of the levels, during such horizontal period, of a vertical rate parabolic voltage V_{P2} , a width control voltage V_W and a vertical rate tilt control voltage V_T , as described later on. In such algebraic sum, the terms representing each of voltage V_{P2} and V_T are multiplied by minus 1 prior to such summation. Tilt control signal V_T is capacitively coupled to an inverting input terminal 41a of an amplifier 41 of modulating circuit 200. Signal V_T , having a substantially sawtooth waveform, controls the tilt of the raster on a television screen, that is not shown in the figures. Parabolic voltage V_{P2} , that provides east-west pincushion correction, is coupled through a resistor 42 to terminal

41a, that operates as a current summing junction. Width control signal V_W , that is a DC voltage, is adjustable by varying a variable resistor 43. Signal V_W is coupled to a noninverting input terminal 41b of amplifier 41 for controlling the width of the raster by controlling the amplitude of the deflection current at the vertical center of the raster.

A horizontal rate retrace voltage V_{R2} that is developed at a secondary winding T1b of flyback transformer T1 has a peak amplitude that is proportional to the magnitude of deflection current i_Y in deflection winding L_Y . Retrace voltage V_{R2} is rectified by a diode D3 to develop, in a capacitor C_P , a DC voltage V_Y that is proportional to the peak voltage of retrace voltage V_{R2} . Thus, voltage V_Y is proportional to the amplitude of deflection current i_Y . Voltage V_Y is coupled through a resistor 44 to current summing terminal 41a to provide a negative feedback signal path. As a result of such conventional negative feedback, deflection current i_Y is controlled to be directly proportional to the algebraic sum of voltages V_T , V_{P2} and V_W , as defined above.

Parabolic voltage V_{P2} is formed from a parabolic voltage V_{P1} that is generated by a parabolic voltage generating circuit 100. The waveform of voltage V_{P1} is illustrated in FIGURE 2b. Vertical rate parabolic voltage V_{P1} has, during each vertical period, a minimum level $V_{P1(MIN)}$, at the center of the vertical interval. Level $V_{P1(MIN)}$ is substantially zero, as described later on. Parabolic voltage V_{P1} of FIGURE 1 is coupled to an end terminal of a variable resistor 45. The other end terminal of resistor 45 is coupled at a junction terminal 45a to a resistor 46. The other terminal of resistor 46 is coupled to ground. Parabolic voltage V_{P2} , having a peak-to-peak amplitude that is adjustable by variable resistor 45, is developed at terminal 45a.

Because parabolic voltage V_{P1} has minimum level $V_{P1(MIN)}$ of FIGURE 2b that is advantageously approximately zero volts, as indicated above, the adjustment of resistor

45 of FIGURE 1 will cause corresponding adjustment of the peak-to-peak amplitude of parabolic voltage V_{p2} without substantially affecting the minimum level of parabolic voltage V_{p2} , because resistors 45 and 46 operate as a
5 linear voltage divider that multiplies parabolic voltage V_{p1} by an adjustable constant fraction to generate voltage V_{p2} . Since the minimum level of parabolic voltage V_{p1} is approximately zero, the minimum level of parabolic voltage V_{p2} , that is equal to parabolic voltage V_{p1} after
10 multiplication by such constant is also zero.

Because of voltage inversion in amplifier 41, when the level of parabolic voltage V_{p2} is at a minimum, that is zero volts, both signal V_{IN} and the B+ operating voltage are at corresponding maximum. The advantageous
15 result is that the peak-to-peak amplitude of deflection current i_y at the center of the vertical interval, that is controlled by the maximum level of the B+ operating voltage, is the same, irrespective of the peak-to-peak amplitude of parabolic voltage V_{p2} .

20 In carrying out an aspect of the invention, adjusting the peak-to-peak amplitude of parabolic voltage V_{p2} to provide the required pincushion raster correction will not affect the raster width that is related to the maximum peak-to-peak amplitude of deflection current i_y .
25 The maximum peak-to-peak amplitude of the deflection current i_y occurs at the vertical center of the raster, that occurs when parabolic voltage V_{p2} is at a minimum.

FIGURE 1 also illustrates parabolic waveform generating circuit 100, embodying aspects of the
30 invention, that generates parabolic voltage V_{p1} . A DC positive signal V_{ST1} that contains a substantially sawtooth waveform varying at the vertical rate, is produced at an output terminal 30a of a vertical amplifier
30. Vertical amplifier 30 comprises a conventionally
35 designed vertical deflection amplifier that generates a vertical deflection current in a vertical deflection winding L_v . Signal V_{ST1} is coupled to the cathode of a diode D2. The anode of diode D2 is coupled to a junction

terminal 31 that is coupled between a resistor 32 and a resistor 33. The other terminal of resistor 32 is coupled to a DC voltage V_{33} that is, illustratively, 15 volts. The other terminal of resistor 33 is coupled through a resistor 34 to ground. The DC voltage that is developed at terminal 31 by the voltage divider formed of resistors 32, 33 and 34 establishes a clipping voltage level as described below. A capacitor C10 is coupled between terminal 34a and ground for filtering out from signal V_{ST2} signals at the horizontal frequency and above.

Each tip a1 of signal V_{ST1} , that is shown in the waveform in the FIGURE 1 that is developed at terminal 30a, is formed during the vertical retrace interval. When signal V_{ST1} exceeds such clipping voltage level, diode D2 is back biased so that a portion of each positive tip a1 of signal V_{ST1} is not coupled to terminal 31. Conversely, when signal V_{ST1} is below such clipping level, signal V_{ST1} is coupled in its entirety to terminal 31 to form a DC, positive, substantially sawtooth signal V_{ST2} at terminal 34a that follows the waveform of signal V_{ST1} . Thus, signal V_{ST2} is a DC voltage having a sawtooth waveform at a vertical rate. Signal V_{ST2} has a fast rising edge portion a2 that occurs during vertical retrace and a slow down-ramping portion a3 having a rate of change that increases gradually from the beginning to the end of vertical trace.

Signal V_{ST2} is coupled to the base electrode of a transistor Q2 that is connected as an emitter follower. The emitter electrode of transistor Q2 couples signal V_{ST2} to a terminal 35 of an input resistor R_{INT} of an integrator 50 to form a DC positive input signal V_{ST3} at terminal 35 having a waveform that is illustrated in FIGURE 2c. Signal V_{ST3} of FIGURE 1 substantially follows the waveform of signal V_{ST2} , except for the DC level shifting caused by the base-emitter junction of transistor Q2.

Signal V_{ST3} is applied to resistor R_{INT} that generates from signal V_{ST3} an alternating current (AC)

input current i_{INT} in resistor R_{INT} . The other terminal of resistor R_{INT} is coupled to an inverting input terminal 36a of an amplifier 36 of integrator 50. An integrating capacitor C_{INT} is coupled between an output terminal 36b of amplifier 36 and inverting input terminal 36a. A noninverting input terminal 36c of amplifier 36 is coupled to a control signal V_M , as described later on. Capacitor C_{INT} , resistor R_{INT} and amplifier 36 form integrator 50 that generates parabolic voltage V_{P1} at output terminal 36b by time-integrating AC input current i_{INT} , having a sawtooth waveform, to develop a voltage V_{CINT} in capacitor C_{INT} .

An inverting input terminal 37a of a feedback amplifier 37 that operates as a voltage comparator is coupled to output terminal 36b of amplifier 36. A noninverting input terminal 37b of amplifier 37 is coupled to an, illustratively, positive constant DC reference voltage V_{REF} that is close to zero volts. Voltage V_{REF} determines, as described later on, the minimum level of parabolic voltage V_{P1} .

An output terminal 37c of amplifier 37 develops a relatively large positive voltage V_{37c} , having a waveform that is illustrated in FIGURE 2a, when voltage V_{P1} of FIGURE 2b that is coupled to terminal 37a, is less positive than reference voltage V_{REF} ; conversely, feedback amplifier 37 of FIGURE 1 develops zero volts at terminal 37a as illustrated in FIGURE 2a when voltage V_{P1} of FIGURE 2b is more positive than reference voltage V_{REF} . A resistor 38 of FIGURE 1 is coupled between output terminal 37c and a terminal of a capacitor C11. The other terminal of capacitor C11 is coupled to ground. The voltage in capacitor C11 is coupled to noninverting input terminal 36c of amplifier 36 to form control signal V_M that is substantially equal to the voltage in capacitor C11. Because the time constant of resistor 38 and capacitor C11 is substantially larger than the vertical period, control signal V_M , that is equal to the voltage in capacitor C11, cannot vary significantly within each vertical period.

Assume, for the purpose of the analysis of parabolic voltage generating circuit 100, that the offset voltages and bias currents of amplifiers 36 and 37 are all zero and that the gain and the bandwidth of each is infinite. The average value of current i_{INT} has to be zero; otherwise, voltage V_{CINT} in capacitor C_{INT} would increase in magnitude indefinitely. Therefore, in steady state, a voltage V_{36a} at inverting input terminal 36a has an average value that is equal to the average value of DC positive signal V_{ST3} at terminal 35. Because of the negative feedback signal path formed by capacitor C_{INT} from output terminal 36b to input terminal 36a of amplifier 36, voltage V_{36a} at terminal 36a is also equal to the voltage of signal V_M at terminal 36c. It follows that, in steady state, the average value of signal V_M is maintained constant and equal to the average value of signal V_{ST3} . Signal V_M is maintained constant by the feedback path from output terminal 36b of amplifier 36 via amplifier 37 to noninverting input terminal 36c of amplifier 36.

In an example of parabolic voltage V_{P1} , shown in FIGURE 2b, a portion T_1 of the vertical interval V is defined as the interval in which voltage V_{P1} , that is coupled to terminal 37a of amplifier 37, is less positive than reference voltage V_{REF} , that is shown in dashed-line in FIGURE 2b. Note that the minimum level $V_{P1(MIN)}$ of parabolic voltage V_{P1} occurs approximately at the center of portion T_1 , that occurs at the center of the vertical interval V .

Feedback amplifier 37 of FIGURE 1 operates as a voltage comparator, of voltages V_{P1} and V_{REF} . A positive current i_{c11} of FIGURE 1 occurs during portion T_1 of vertical interval V of FIGURE 2b when parabolic voltage V_{P1} is less positive than reference voltage V_{REF} . Positive current i_{c11} is caused by the positive pulse of voltage V_{37c} that is illustrated in FIGURE 2a. In contrast, a negative current i_{c11} occurs during the remainder of the vertical cycle when parabolic voltage V_{P1} of FIGURE 2b is

more positive than reference voltage V_{REF} . When parabolic voltage V_{P1} is more positive than reference voltage V_{REF} , voltage V_{37C} of FIGURE 2a of comparator, or amplifier 37 of FIGURE 1 is zero. When voltage V_{37C} is zero, negative current i_{C11} discharges capacitor C11.

Because of the positive pulse of voltage V_{37C} that occurs during portion T_1 of FIGURE 2a, positive current i_{C11} of FIGURE 1 that flows in resistor 38 charges capacitor C11 during portion T_1 of FIGURE 2a of vertical interval V. Negative current i_{C11} discharges capacitor C11 during the remainder portions of vertical interval V of FIGURE 2a. In steady state, signal V_M of FIGURE 1 is substantially constant and equal to the average value of signal V_{ST3} as described before. It follows that, for example, during portion T_1 of vertical interval V, the charge added by positive current i_{C11} has to be equal to the charge that is removed by negative current i_{C11} during the remainder of interval V. Positive voltage V_{37C} of FIGURE 2a, that is large relative to the level of signal V_M of FIGURE 1, causes the flow of positive current i_{C11} of FIGURE 1. The result is that positive current i_{C11} has a peak current that is substantially larger than that of negative current i_{C11} that flows in resistor 38 when voltage V_{37C} is zero.

Thus, in steady state operation, the duration of portion T_1 of FIGURE 2b, during which the minimum level $V_{P1(MIN)}$ of parabolic voltage V_{P1} occurs, is determined by the average value in each vertical period of positive current i_{C11} relative to that of negative current i_{C11} . Positive current i_{C11} that is large and that flows during portion T_1 has to replenish, during portion T_1 , the same charge that was lost in capacitor C11 as a result of negative current i_{C11} during the remainder of the vertical interval that is longer than portion T_1 . In steady state, the average value of signal V_M that is maintained substantially constant and as described above, is equal to the average value of signal V_{ST3} . It follows that in steady state, the ratio between the duration of portion T_1

and the remainder of the vertical interval V is directly related to a ratio RT between the average value of negative current i_{c11} during portion T_1 to the average value of positive current i_{c11} during the remainder of vertical interval V of FIGURE 2a. Note that positive current i_{c11} is substantially larger than that of negative current i_{c11} .

Voltage V_{CINT} in capacitor C_{INT} is the sum of an AC component voltage having a peak-to-peak amplitude that is determined by the peak-to-peak amplitude of signal V_{ST3} and of a DC component voltage that is controlled by signal V_M , as described later on. Voltage V_{P1} is equal to voltage V_{36a} , that is equal to signal V_M , minus voltage V_{CINT} . Thus, voltage V_{P1} of FIGURE 2b is equal to the sum of a DC component voltage V_{P1DC} and an AC component voltage V_{P1AC} . Signal V_M of FIGURE 1 varies the level of DC component voltage V_{P1DC} of FIGURE 2b by causing the average value of voltage V_{CINT} of FIGURE 1 to vary, as described later on. As may be concluded by observing FIGURE 2b, when DC component voltage V_{P1DC} becomes, for example, more positive, the duration of portion T_1 , that occurs when voltage V_{P1} is less positive than voltage V_{REF} , decreases. On the other hand, when voltage V_{P1DC} becomes less positive, the duration of portion T_1 increases.

Also assume, that as a result of some disturbance, such as an increase in the amplitude of the AC component voltage of signal V_{ST3} of FIGURE 1, the duration of portion T_1 of FIGURE 2b is longer than the required duration for correct steady state operation. As described before, the required duration of portion T_1 is determined by ratio RT between the average value of negative current i_{c11} of FIGURE 1 and that of positive current i_{c11} . Consequently, the average value of signal V_M will gradually increase in each vertical period, causing signal V_M to have, during a transient mode of operation, an average value that exceeds the average value of signal V_{ST3} . As long as the average value of signal V_M

is more positive than the average value of signal V_{ST3} , voltage V_{36a} at terminal 36a, that is equal to signal V_M at terminal 36c of amplifier 36, causes a net, or average negative current i_{INT} to flow, causing the average value of voltage V_{CINT} to gradually become less positive. When voltage V_{CINT} becomes less positive, DC component voltage V_{P1DC} of FIGURE 2b becomes more positive. The result is that the duration decreases. This duration in which voltage V_{P1} is less positive than voltage V_{REF} was defined as portion T_1 . Thus, the duration of portion T_1 is gradually decreased until, in steady state, portion T_1 attains the duration that is determined, as described before, by ratio RT between the average value of negative current i_{c11} and that of positive current i_{c11} . By controlling DC component voltage V_{P1DC} of FIGURE 2b, signal V_M of FIGURE 1 causes the duration of portion T_1 of FIGURE 2b to assume the required steady state length. Note, that when steady state is achieved, signal V_M of FIGURE 1 is, again, substantially a DC voltage that is equal to the average value of signal V_{ST3} .

During portion T_1 of FIGURE 2b, the minimum parabolic level $V_{P1(MIN)}$ of voltage V_{P1} occurs. At the time in which level $V_{P1(MIN)}$ occurs, the rate of change of parabolic voltage V_{P1} is zero. During portion T_1 , voltage V_{P1} does not deviate significantly from the level of reference voltage V_{REF} , because during portion T_1 , the parabolic waveform of voltage V_{P1} changes at a slow rate of change. Such slow rate of change is caused by the fact that current i_{INT} of FIGURE 1 is then small. It follows that minimum level $V_{P1(MIN)}$ of parabolic voltage V_{P1} of FIGURE 2b that occurs during portion T_1 has a value that is between zero volts and the level of reference voltage V_{REF} that is a small positive voltage.

In carrying out another aspect of the invention, control signal V_M of FIGURE 1 is automatically adjusted to the average level of signal V_{ST3} to cause the average value of input current i_{INT} to be zero. Advantageously, integrator 50 is capable of integrating DC signal V_{ST3}

without the need for using a DC blocking capacitor that may adversely affect the shape of the required parabolic waveform of voltage V_{P1} .

As described before, because the minimum level $V_{P1(MIN)}$ of voltage V_{P1} is approximately zero volts, the minimum level of parabolic voltage V_{P2} of FIGURE 1 is independent of the peak-to-peak amplitude of voltage V_{P2} . Therefore, the raster width does not significantly change when adjusting resistor 45 to vary the amplitude of parabolic voltage V_{P2} .

In carrying out an additional aspect of the invention, the DC, sawtooth waveform, signal V_{ST3} is direct-current coupled throughout the signal path that extends from terminal 35 of resistor R_{INT} to terminal 27 in which the B+ operating voltage is developed. No DC blocking capacitor is used in such signal path that forms the parabolic component voltage of the B+ operating voltage. That no DC blocking capacitor is used is advantageous because a DC blocking capacitor at the low frequency vertical rate of signal V_{ST3} may have to be of a large value. Such DC blocking capacitor could also disadvantageously degrade operating reliability because the capacitor could become leaky after a period of service.

The rate of change of downramping signal V_{ST3} of FIGURE 2c, tracks, or follows, the downramping portion a3 of signal V_{ST2} of FIGURE 1, having a rate of change that gradually increases from the beginning to the end of vertical trace. Such rate of change of signal V_{ST3} of FIGURE 2c is preferable to a straight line downramping portion, such as an ideal sawtooth waveform, for obtaining, by the integration process of integrator 50, the desirable parabolic waveform that provides east-west pincushion distortion correction.

Transistor Q2 of FIGURE 1 operates also as a phase splitter. A voltage summing resistor 60 that is coupled between the emitter and collector electrodes of transistor Q2 produces at a wiper WP of resistor 60.

sawtooth waveform tilt control voltage V_T having magnitude and polarity that are variable by adjusting the position of wiper WP. Voltage V_T is capacitively coupled to terminal 41a of amplifier 41. Varying the peak-to-peak
5 amplitude of voltage V_T has little effect on the width of the raster, because, in the vertical center of the raster, the current that flows in resistor 47 and capacitor 48 that is caused by voltage V_T is zero.



CLAIMS:

1. A television display apparatus, responsive to an input signal for generating therefrom a periodic parabolic output signal at a deflection related frequency, comprising:

a source of said input signal;

a source of a reference signal;

first means responsive to said input signal for generating therefrom said output signal having a substantially parabolic waveform;

second means responsive to said output signal and to said reference signal for generating therefrom a first control signal that is indicative of the magnitude of a difference therebetween, said first control signal including, in a given period of said output signal that occurs in steady state operation, both a first portion signal that is caused as a result of the difference being at a first polarity, and a second portion signal that is caused as a result of the difference being at the opposite polarity such that said first control signal varies during said given period; and

third means responsive to said first control signal for time integrating said first control signal to generate therefrom a second control signal at a magnitude that is in accordance with a relation between one of said first and second portion signals and the other one, said second control signal being applied to said first means for maintaining said parabolic output signal that occurs during a corresponding predetermined interval of said given period of said output signal at a level that is determined in accordance with said reference signal.



2. A display apparatus according to Claim 1 further comprising means for adjusting the amplitude of said output signal such that said level of said output signal that occurs during said corresponding predetermined interval of said given period remains the same after adjusting the amplitude of said output signal.

3. A display apparatus according to Claim 2 wherein said adjusting means comprises an adjustable resistor so that by adjusting said resistor, the amplitude of said output signal is adjusted in such a manner that said level of said output signal that occurs during said corresponding predetermined interval of said given period remains the same after adjusting said resistor.

4. A display apparatus according to Claim 2 further comprising means responsive to said output signal for generating a deflection current, in a deflection winding of a picture tube, that varies in a parabolic manner in accordance with the adjustment of the amplitude of said output signal for obtaining the required parabolic variation of said deflection current to provide raster distortion correction in said picture tube, and wherein the width of the raster is related to said level of said output signal that remains the same after adjusting the amplitude of said output signal so as to enable the width of the raster to remain the same.

5. A display apparatus according to Claim 1 wherein said first means comprises a capacitor and means responsive to said input signal for generating a substantially sawtooth current from said input signal that is coupled to said capacitor such that the voltage developed in said capacitor is substantially equal to the time-integral of said sawtooth current.



6. A television display apparatus according to Claim 1 wherein said third means is responsive to said first control signal for developing an average voltage in a capacitor that varies in accordance with the difference between said output and reference signals.

7. A television display apparatus according to Claim 1 wherein said second means comprises a voltage comparator that generates a pulse portion of said first control signal during said predetermined interval.

8. A television display apparatus according to Claim 7 wherein said third means comprises a first capacitor and means responsive to said first control signal for generating in said first capacitor said second control signal that, in steady state operation, is substantially a DC signal, said second control signal having a value that varies in accordance with the duration of said pulse.

9. A television display apparatus according to Claim 8 wherein said first means comprises a second capacitor for developing a first parabolic waveform in said second capacitor and wherein said second control signal is coupled to said second capacitor for controlling the average voltage in said second capacitor in accordance with the relative durations of said first and second portion signals of said first control signal.

10. A television display apparatus according to Claim 1 wherein said first control signal generating means includes means for generating a pulse in said predetermined interval that includes an instant in which the rate of change of said parabolic output signal is zero.



11. A display apparatus according to Claim 10 wherein said parabolic output signal changes relatively little during said pulse.

12. A display apparatus according to Claim 11, wherein said output signal includes a DC component voltage, said pulse varying in accordance with said reference signal.

13. A television display apparatus according to Claim 1 wherein said first means comprises an amplifier and an integrating capacitor, and said second means comprises a comparator for generating a pulse voltage, and wherein said third means is responsive to said pulse voltage for generating said second control signal that is applied to an input terminal of said amplifier in a negative feedback manner.

14. A television display deflection apparatus for generating a deflection current in a deflection winding at a first deflection frequency to produce a raster in a television imaging device, comprising:

a deflection circuit output stage for generating a periodic deflection current in said deflection winding at said first deflection frequency, said deflection current that occurs during scanning of a center of the raster having an amplitude that determines the width of the raster;

means coupled to said output stage for producing a periodic parabolic voltage at a second frequency having an adjustable amplitude that modulates the amplitude of said deflection current in a parabolic manner in accordance with said parabolic voltage, said parabolic voltage including a portion that determines the width of the raster;



a source of a reference signal;
means responsive to said portion of said parabolic voltage that determines the width of the raster and to said reference signal for generating a control signal, in accordance with a difference therebetween, that is applied to said parabolic voltage producing means to control, in accordance with said reference signal, a level of said portion that determines the width of the raster; and

means for adjusting the amplitude of said parabolic voltage in such a way that after an adjustment of the amplitude of said parabolic voltage, the amplitude of said deflection current that occurs during scanning of said predetermined portion of the raster is not affected so as to maintain the width of the raster unchanged by said adjustment.

15. An apparatus according to Claim 1 wherein said output signal changes in accordance with a duration of said first portion signal relative to that of said second portion signal of said first control signal.

16. An apparatus according to Claim 15 wherein said first and second portions of said first control signal define a rectangular waveform, such that a change in said output signal causes a corresponding change in a duty cycle of said rectangular waveform.

17. An apparatus according to Claim 16 wherein said change in said output signal from a first steady state amplitude thereof to a second steady amplitude thereof causes the duty cycle of said control signal to change in only a transient manner.

18. An apparatus according to Claim 1 wherein said first means comprises an integrator responsive to said input signal for time-integrating said input signal to produce a said output signal.



19. An apparatus according to Claim 18 wherein said input signal has a sawtooth waveform.

20. A television display apparatus according to Claim 1 wherein said first control signal is applied to said first means for maintaining a portion of said parabolic output signal that occurs during a corresponding predetermined interval of a given period of said output signal at a level that is determined in accordance with said reference signal such that when a change occurs in an average value of said input signal from a first to a second steady state value, said first control signal prevents said level of said output signal that occurs during said predetermined interval from being substantially affected.

21. A parabolic signal generating circuit substantially as hereinbefore described with reference to the accompanying drawings.
