

PATENT SPECIFICATION

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DRAWINGS ATTACHED



1 266 028

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(54) VOLTAGE REGULATOR FOR USE IN A TELEVISION RECEIVER

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement.—

This invention relates to voltage supplies and more particularly to a regulated high voltage supply suitable for supplying the ultor or final anode voltage requirements of a cathode ray tube.

One use of such an ultor voltage supply which is of particular interest is a shadow-mask type of color kinescope. The various aspects of the present invention therefore will be described in connection with such a display device as it is used in a color television receiver.

In the design of color television receivers, it is a customary practice to develop the ultor supply voltage by rectification of fly-back pulses produced in an associated horizontal deflection output transformer. Additionally, color television receivers commonly employ some form of regulator (e.g., a shunt regulator or ballast tube) coupled to the ultor voltage supply for maintaining ultor voltage (and, in the case of a shunt regulator, the load on the horizontal output transformer) relatively constant as kinescope beam current (ultor load) varies. In British Patent Application No. 18631 filed April 11, 1969 (Serial No. 1,260,375) an arrangement is described wherein reactive components (inductance and capacitance) are selected so as to maintain image width substantially constant as beam current varies. That is, the components may be selected so that, as ultor voltage varies, a compensating variation is produced in the deflection current supplied to an associated deflection yoke so as to maintain image width substantially constant.

Ultor supply voltage, in addition to being
 [Price 25p]

affected by kinescope beam current variations, may also vary as line voltage and/or the main supply voltage (B+) of the television receiver varies. Consequent variations also may be produced in the beam deflection current so as to produce variations in image size (e.g., width) as line or main supply voltage varies.

It is an object of the present invention to maintain ultor supply voltage, horizontal deflection current, and image width substantially constant as the main supply voltage varies in a television receiver.

In accordance with the present invention, there is provided, for use in a television receiver having an image display device, a deflection and high voltage generating circuit for supplying high voltage to said display device and for supplying a related deflection current, said circuit comprising a voltage source serially direct current coupled to a variable reactance for supplying current to at least one energy storage capacitance during a trace portion of each deflection cycle, and a semiconductor switch for coupling said energy storage capacitance to said deflection and high voltage generating circuit during at least a retrace portion of each deflection cycle, and further comprising control means operative on said variable reactance and responsive to variations in said high voltage for varying the current supplied to said energy storage capacitance so as to control the operating current supplied to said deflection and high voltage generating circuit to maintain image size substantially constant.

Referring to the accompanying drawing:

Figure 1 illustrates in block and schematic form a color television receiver including a horizontal deflection and regulated high voltage circuit constructed in accordance with the present invention;

Figure 2 illustrates voltage and current waveforms, (not drawn to scale) occurring in the circuit illustrated in Figure 1 during each horizontal line scanning interval.

In Figure 1, a color television receiver

which may be of a generally conventional type is illustrated in block form, with, however, details of the horizontal output circuitry and associated high voltage supply, shown schematically. In the typical receiver 11, a carrier wave modulated by composite color television signals is received by signal receiving apparatus which includes the usual R.F. tuner, frequency converting apparatus, I.F. amplifier and video detector. Video signals are recovered in the receiving apparatus from the modulated carrier and are amplified in a video amplifier. The amplified video signals are supplied to a keyed AGC circuit which controls amplifier gain in the signal receiving apparatus in accordance with conventional automatic gain control principles. The video signals also are applied to a luminance channel, to a chrominance channel and to a synchronizing signal separator. The chrominance channel processes the color information to a form suitable for application to a color image reproducer. A three-gun shadow mask color kinescope 13 serves as the color image reproducer of the illustrated receiver.

A deflection yoke 19 is associated with the color kinescope 13 and responds to respective vertical and horizontal deflection waves to cause the individual beams produced by color kinescope 13 to trace a raster on the phosphor screen. A convergence yoke (not shown) which responds to suitable dynamic convergence waveforms to cause the color kinescope beams to properly converge in the target region throughout the scanning of the raster is also customarily associated with kinescope 13.

The color signal outputs of the chrominance channel are applied individually to the respective control grids of the kinescope 13. The respective cathodes are driven by the output of the luminance channel which serves to amplify the luminance component of the composite signal and includes suitable delay apparatus to equalize the delay of the luminance component with the delay encountered by the chrominance information in the chrominance channel.

The output of the sync separator is supplied to the vertical deflection circuits and to a horizontal deflection oscillator 21. The vertical deflection circuits generate a vertical deflection wave for application to the terminals V_1 , V_2 of the deflection yoke 19, under the control of vertical synchronizing apparatus. The horizontal oscillator 21, which may be a conventional blocking oscillator, develops a periodic switching voltage under the control of horizontal synchronizing pulses derived from the sync separator ing pulses derived from the sync separator apparatus. The oscillator 21 is associated with suitable deflection AFC apparatus (not

shown) for assuring the desired synchronization.

The periodic switching voltage developed by oscillator 21 is applied to a horizontal deflection circuit indicated generally by the reference numeral 23.

Deflection circuit 23 is of the type shown and described in the previously mentioned Application No. 18631/69 (Serial No. 1,260,375). Briefly stated, deflection circuit 23 comprises a bilaterally conductive trace switching means 25 comprising a silicon controlled rectifier (SCR) 27 and a diode 29 for coupling a relatively large capacitor 31 across a horizontal deflection winding 33 during the trace portion of each deflection cycle. An energy storage capacitor 35 and a commutating inductor 37 are coupled between trace switching means 25 and a bilaterally conductive commutating switching means 39, which comprises a silicon controlled rectifier 41 and a diode 43. A second capacitor 45 is coupled from the junction of capacitor 35 and commutating inductor 37 to ground. A main voltage supply (B+) is coupled to a relatively large supply inductor 47, which in turn, is coupled to the junction of commutating inductor 37 and commutating switching means 39.

First triggering means 49 is coupled from inductor 47 to SCR 27 for initiating conduction in SCR 27 during the trace portion of each deflection cycle. Second triggering means 51 is coupled from horizontal oscillator 21 to SCR 41 for initiating conduction therein near the end of the trace portion of each deflection cycle.

The primary winding 53a of a horizontal deflection output transformer 53 is coupled to deflection winding 33 and is returned to ground by means of a protection circuit 55.

Deflection winding 33 and trace diode 29 are coupled to the terminal H on transformer 53 which, for example, is at a voltage level slightly higher than the end terminal on primary winding 53a so as to compensate for the difference in voltage required across diode 29 and SCR 27 during their respective conduction periods.

A secondary step-up winding 53b having a high voltage tap (terminal) 53c, a focus voltage tap 53d and a screen voltage tap 53e is returned to ground at its lower end. A high voltage rectifier 57 is coupled between high voltage tap 53c and the ultor electrode 17 of kinescope 13 for supplying a high beam accelerating voltage (e.g., of the order of 25,000 volts) to kinescope 13.

A screen voltage supply 59 is coupled between screen voltage tap 53e and ground while a focus voltage supply 61 is coupled between focus voltage tap 53d and focus electrode 15. Screen supply 59 and focus supply 61 may be of the type described in British Patent Application No. 49412,

filed Oct. 18, 1968 (Serial No. 1,219,139), entitled "Voltage Supply".

5 A protective circuit 63 arranged to limit positive polarity voltage excursions is coupled across SCR 27.

10 A sensing means comprising the series combination of a resistor 65, a variable high voltage adjustment resistor 67 and a resistor 69 is coupled across energy storage capacitor 31. A reference voltage Zener diode 71 is coupled between the variable contact of resistor 67 and the input of a control means comprising a transistor amplifier 73.

15 Transistor 73 is an NPN type and comprises a base electrode coupled to Zener diode 71, an emitter electrode coupled to ground and a collector electrode coupled to a source of operating voltage $+V_a$ by a control winding 75a of a saturable reactor 75. A recovery diode 77 is coupled across control winding 75a.

20 Series connected secondary (load) windings 75b and 75c operatively associated with control winding 75a are coupled across supply inductor 47 by means of the parallel combination of a diode 79 and a resistor 81.

25 The operation of the deflection circuit 23 will be restated in part below as it applies to the present invention.

30 At the beginning of the trace portion of each horizontal (line) deflection cycle, the current in deflection winding 33 is at a maximum amplitude and is flowing in the direction from terminal H to terminal H'. Diode 29 in trace switching means 25 is forward biased at this time and acts to couple deflection winding 33 across capacitor 31 during the first half of trace. The deflection current declines substantially linearly and produces a gradual increase in the voltage across capacitor 31 (see Figure 2, waveform B) during the first half of trace. Approximately midway through the trace portion of the cycle, the current through deflection winding 33 passes through zero, reverses and switches from diode 29 to SCR 27. SCR 27 is placed in standby condition in preparation for this switching of current paths by means of a gating signal provided by triggering circuit 49. When SCR 27 commences conduction, capacitor 31 remains coupled across winding 33. However, energy now is transferred from capacitor 31 to winding 33 via SCR 27 and the voltage across capacitor 31 declines gradually as the deflection current in winding 22 increases substantially linearly during the latter half of the trace interval.

60 During the time the trace switching means 25 is conductive as described above and commutating switching means 39 is open (i.e., nonconductive), capacitors 35 and 45 are coupled in parallel across a current supply comprising the series combination of inductors 37 and 47 coupled to the main

voltage supply (B+) of the receiver. Inductor 47, which stores energy during the commutating portion of each deflection cycle (see below), transfers a portion of its stored energy to capacitors 35 and 45 while they are coupled in parallel. The voltage across the parallel combination of capacitors 35 and 45 typically increases during this interval (see solid line ramp portion of waveform A—the voltage across switch 25). A portion of the energy so stored in capacitors 35 and 45 is transferred during the retrace portion of each deflection cycle to deflection winding 33 and to the voltage generating circuits associated with transformer 53 including high voltage rectifier 57.

80 In order to initiate the retrace portion of each deflection cycle and to transfer energy from capacitors 35 and 45, several microseconds before the desired end of trace, a pulse is produced by horizontal oscillator 21. This pulse is shaped by triggering means 51 and the resultant waveform is applied to the gate electrode of commutating SCR 41. SCR 41 commences conduction and thereby completes a first closed circuit path comprising trace switching means 25, capacitor 35, inductor 37 and commutating switching means 39 and a second closed circuit path comprising commutating switching means 39, inductor 37 and capacitor 45. The current in deflection winding 33 temporarily continues to increase since trace switch 25 remains closed. The energy stored in capacitors 35 and 45 is circulated in the first and second circuit paths in a resonant manner. At the same time, inductor 47 is coupled (by commutating switch 39) directly across the B+ supply producing an approximately linearly increasing current and substantial energy storage in inductor 47.

95 The current component associated with capacitor 35 serves to turn off SCR 27 (i.e., that component flows through SCR 27 in the reverse direction) and, after a further short interval of conduction by trace diode 29, the retrace portion of the deflection cycle is initiated.

100 During the retrace interval, a complex sequence of energy exchange takes place among deflection winding 33, inductance 37, capacitors 35 and 45 and the high voltage supply circuit including transformers 53, rectifier 57 and the load at the kinescope high voltage electrode 17. Stated briefly, the current in deflection windings 33 is reversed as a result of a resonant half-cycle energy exchange between windings 33 and the combination of inductor 37, capacitors 35 and 45 and the equivalent tuned circuit of transformer 53. A high voltage flyback pulse waveform is produced during retrace at the high voltage tap 53c and is rectified by rectifier 57 to produce a direct operating

voltage of the order of 25,000 volts at electrode 17 of kinescope 13.

5 The magnitude of the high voltage pulse is related directly to the peak magnitude of the deflection current in deflection winding 33 and to the magnitude of the voltage (stored energy) associated with capacitors 35 and 45 at the beginning of the retrace portion of the deflection cycle. The peak
10 magnitude of the deflection current also is dependent upon the voltage (stored energy) associated with capacitors 35 and 45. The values of capacitors 35 and 45 and inductor 37 may be selected so that, without additional high voltage regulating means separate
15 from that applied to the deflection circuit, for a given percentage change in high voltage, a predetermined percentage change will occur in peak deflection current. For example, for a ten percent change in high voltage, components 35, 45 and 37 may be
20 selected to produce a change in peak deflection current in the range of 0-10%. For a particular set of selected values for capacitors 35 and 45, the ratio of the percentage change in deflection current to the percentage change in high voltage increases
25 for a decrease in the value of inductance 37.

30 In the particular illustrated embodiment of the present invention, the component values are selected to produce a percentage change in peak deflection current at least one-half, but preferably equal to a corresponding percentage change in high voltage in the absence of additional regulating
35 means.

The single regulating means is coupled to inductor 47 for varying the input power supplied to deflection circuit 23 as high voltage and peak deflection current vary. The
40 regulating means are arranged to maintain image width substantially constant over the expected operating range of supply voltage (B+) and beam current variations. Furthermore, the regulating means are arranged to
45 maintain not only the high voltage but also the peak deflection current substantially constant for a variation in supply voltage of the order of twenty percent. The latter quantity is an advantageous preferred feature.
50

In the regulator circuit, means are provided for sensing variations in high voltage produced at ultor electrode 17. Since it is
55 desirable to provide such sensing in a relatively low voltage circuit and furthermore, as noted above, since deflection trace current changes and high voltage changes are related in a substantially fixed manner by circuit constraints, the means for sensing
60 variations in high voltage are coupled across capacitor 31. The voltage across capacitor 31 reflects changes in deflection current and therefore reflects changes in high voltage.

65 In operation, the peak value of the volt-

age produced across capacitor 41 (waveform B) at approximately the midpoint of the trace portion of each deflection cycle is directly related to the peak deflection current produced in deflection windings 33. A
70 portion of the voltage produced across capacitor 31 is selected by means of variable resistance 67 and is compared to a fixed voltage reference provided by the combination of Zener diode 71 and the base-emitter
75 junction of transistor 73. The difference between the selected portion of the voltage across capacitor 31 and the fixed reference voltage is coupled to transistor 73 so as to produce, typically, a unidirectional current
80 pulse (see waveform C) in the output circuit of transistor 73 in the vicinity of the midpoint of the trace portion of the deflection cycle. The current supplied by transistor 73
85 flows through control winding 75a of saturable reactor 75 so as to produce magnetic flux therein which also links with windings 75b and 75c. Unidirectional current is sustained in control winding 75a, after transistor 73
90 ceases conduction, by means of the unidirectional current path provided by diode 77.

Current also flows in the load windings 75b, 75c (see waveform D) during each deflection cycle. The effective inductance of
95 windings 75b and 75c, which is coupled in parallel with supply inductance 47, is inversely related to the current flowing in control winding 75a according to the characteristics of saturable reactor 75. An increase in current in control winding 75a has
100 the effect of reducing the inductance of the parallel combination of inductor 47 and windings 75b and 75c and the converse also is true.

In the illustrated circuit configuration, an increase in main supply voltage (B+) tends to produce equal percentage increases in high voltage at ultor electrode 17 and peak
105 deflection current supplied to deflection winding 33. However, an increase in deflection current produces an increase in the peak voltage across capacitor 31 which, in turn, causes an increase in the current supplied to control winding 75a by transistor
110 73. The effective inductance of the parallel combination of inductor 47 and windings 75b and 75c therefore decreases so that the voltage across capacitors 35 and 45 increases during the initial half of the trace interval, but during the last half of trace, that voltage
115 decreases as energy is returned via inductor 47 to the B+ supply (see dash line portion of waveform A for voltage across capacitors 35 and 45). As a result, the
120 energy available for transfer to the high voltage circuit and to deflection windings 33 is maintained substantially constant, thereby maintaining deflection current, high voltage and image width substantially constant de-
125 130

spite changes in the B+ supply voltage.

When the B+ supply voltage decreases, the effective supply inductance (47, 75b, 75c) is increased to maintain the desired constant image width. The solid line portion of waveform A represents the maximum inductance condition. Saturable reactor 75 is arranged to reduce this maximum inductance sufficiently so that, for high supply voltage conditions, the effective supply inductance and the parallel combination of capacitors 35 and 45 have a natural resonant frequency sufficiently high that energy is returned to the B+ supply near the end of trace (i.e., the voltage across capacitors 35 and 45 peaks before the end of trace and then declines).

If beam current changes in kinescope 13, the circuit operates as follows. Assume beam current increases. The high voltage produced at ultor electrode 17 tends to decrease and the current in deflection winding 33 also tends to decrease. The ratio between the percentage change in deflection current and the percentage change in high voltage is determined by the circuit reactive impedances as stated above. With a selected ratio of unity, if it were not for the presence of the components 65-81, image width would tend to decrease. However, the decrease in deflection current is sensed at transistor 73 and the inductance of saturable reactor 75 is increased so as to increase the energy (voltage) supplied to capacitors 35 and 45 to restore deflection current and high voltage to their nominal values.

A ratio of less than unity also may be utilized which will result in relatively constant image width over a selected range of beam current variations and substantially constant high voltage, deflection current and image width over a wide range of main B+ supply voltage variations.

While the invention has been described in terms of a preferred embodiment thereof, various modifications may be made within the scope of the broad aspects of the invention. For example, Zener diode 71 may be coupled between the emitter electrode of transistor 73 and ground, or Zener diode 71 may be eliminated and adjustment may be made in the relative values of resistors 65, 67 and 69. Transistor 73 may be eliminated in a particular use. Furthermore, an input signal responsive to variations in high voltage and/or deflection current may be derived from circuit components other than capacitor 31. For example, the capacitor in protection circuit 55 which is coupled to transformer primary winding 53a may be so used. The supply voltage (+V_s) required for transistor 73 also may be derived, after suitable filtering, from the capacitor in protection circuit 55.

For particular uses, it is also possible to utilize load windings 75b and 75c directly as the supply inductor and thereby eliminate the separate inductor 47. While the resistor 67 is variable to permit adjustment of the high voltage produced at ultor electrode 17, it may also be desirable, in a particular use, to eliminate such an adjustment by, for example, making resistor 67 a fixed resistor.

One particular configuration corresponding to that illustrated in Figure 1 is set forth below in terms of component values.

SCR 27	...	...	RCA Type 37699	
Diode 29	...	...	Type IN4826	80
Capacitor 31	...	...	1.5 microfarads	
Deflection winding 33	...	...	450 microhenries	
Capacitor 35	...	...	.068 microfarads	
Inductor 37	...	...	55 microhenries	
SCR 41	...	...	RCA type 37700	85
Diode 43	...	...	Type IN4826	
Capacitor 45	...	...	.047 microfarads	
Inductor 47	...	...	15 millihenries	
Transformer 53	...	...	1.2 millihenries (primary)	90
			120 microhenries (leakage)	
			.022 microfarads (distributed C)	
Rectifier 57	...	...	Type 3CZ3	95
Resistor 65	...	...	4700 ohms	
Resistor 67	...	...	180 ohms (variable)	
Resistor 69	...	...	510 ohms	
Zener diode 71	...	...	6.8 volts Zener	
Transistor 73	...	...	Type 2N3440	100
Reactor 75	...	...	3 to 8 millihenries (load windings 75b, 75c) (variable)	
Diode 77	...	...	Type FD 222	
Diode 79	...	...	Type 2A200	105
Resistor 81	...	...	1,000 ohms	
B+	...	...	+140 volts	
+V _s	...	...	+60 volts	

WHAT WE CLAIM IS:—

1. For use in a television receiver having an image display device, a deflection and high voltage generating circuit for supplying high voltage to said display device and for supplying a related deflection current, said circuit comprising a voltage source serially direct current coupled to a variable reactance for supplying current to at least one energy storage capacitance during a trace portion of each deflection cycle, and a semiconductor switch for coupling said energy storage capacitance to said deflection and high voltage generating circuit during at least a retrace portion of each deflection cycle, and further comprising control means operative on said variable reactance and responsive to variations in said high voltage for varying the current supplied to said energy storage capacitance so

spite changes in the B+ supply voltage.

When the B+ supply voltage decreases, the effective supply inductance (47, 75b, 75c) is increased to maintain the desired constant image width. The solid line portion of waveform A represents the maximum inductance condition. Saturable reactor 75 is arranged to reduce this maximum inductance sufficiently so that, for high supply voltage conditions, the effective supply inductance and the parallel combination of capacitors 35 and 45 have a natural resonant frequency sufficiently high that energy is returned to the B+ supply near the end of trace (i.e., the voltage across capacitors 35 and 45 peaks before the end of trace and then declines).

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A ratio of less than unity also may be utilized which will result in relatively constant image width over a selected range of beam current variations and substantially constant high voltage, deflection current and image width over a wide range of main B+ supply voltage variations.

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Resistor 69	...	...	510 ohms	
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Transistor 73	...	...	Type 2N3440	100
Reactor 75	...	...	3 to 8 millihenries (variable)	
			(load windings 75b, 75c)	
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Diode 79	...	...	Type 2A200	105
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+V _s	...	...	+60 volts	

WHAT WE CLAIM IS:—

1. For use in a television receiver having an image display device, a deflection and high voltage generating circuit for supplying high voltage to said display device and for supplying a related deflection current, said circuit comprising a voltage source serially direct current coupled to a variable reactance for supplying current to at least one energy storage capacitance during a trace portion of each deflection cycle, and a semiconductor switch for coupling said energy storage capacitance to said deflection and high voltage generating circuit during at least a retrace portion of each deflection cycle, and further comprising control means operative on said variable reactance and responsive to variations in said high voltage for varying the current supplied to said energy storage capacitance so



as to control the operating current supplied to said deflection and high voltage generating circuit to maintain image size substantially constant.

- 5 2. A circuit according to Claim 1, comprising a voltage reference circuit using a Zener diode and a voltage divider coupled to said control means responsive to variations in said high voltage for varying said
10 variable reactance in a compensating manner to maintain image size substantially constant.

3. A circuit according to Claim 1 or 2, in which said variable reactance comprises a variable inductance.

- 15 4. A circuit according to Claim 3, in which said variable reactance comprises a saturable reactor having control windings coupled to said control means and variable
20 reactance load windings operatively associated with said control windings and coupled to said energy storage capacitance for varying the energy supplied thereto in response to variations in said high voltage.

- 25 5. A circuit according to Claims 2, 3, or 4 having a deflection winding and an energy storage capacitor coupled to said deflection winding during the trace portion of each deflection cycle, in which said voltage reference circuit is coupled across said energy
30 storage capacitor.

6. A circuit according to any of Claims 2—5, in which said voltage reference cir-

cuit comprises a variable voltage divider, coupled to said Zener diode for selectively setting high voltage.

7. A circuit according to Claim 4, or to Claim 5 or 6 when appendent to Claim 4, in which said variable reactance further comprises a substantially fixed value inductor, a first diode coupling said load windings across said fixed inductor, and a second diode coupled across said control winding.

8. A circuit according to Claims 3—7, in which said reactive circuit further includes an inductor which is selected so that said control means produces in response to varying current loads on said high voltage generating circuit, a ratio of percentage change of deflection current to the percentage change of high voltage greater than one-half, but not greater than unity.

9. A regulated deflection and high voltage generating circuit substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing.

10. A television receiver including a circuit according to any preceding claim.

T. I. M. SMITH,
Chartered Patent Agent,
50 Curzon Street,
London, W.1.
Agent for the Applicants.

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