

PATENT SPECIFICATION

DRAWINGS ATTACHED

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(54) BRIGHTNESS LIMITERS FOR TELEVISION RECEIVERS

(71) We, RCA CORPORATION, (formerly known as Radio Corporation of America), 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 television receivers and more particularly to automatic power drive control circuits for a kinescope employed therein.

In a conventional television receiver a brightness control is usually provided for adjusting the bias between the grid and cathode electrodes of a kinescope. In essence such brightness variations can be obtained by a d.c. control that serves to affect the quiescent operating point between the grids and cathodes of this kinescope and thereby obtain a greater or lesser effect on the background qualities of the scene to be displayed.

Certain conventional color television receivers employ brightness control by means of a d.c. level shift which operates on the quiescent bias of a luminance amplifier chain incorporated in a television receiver. This luminance amplifier processes the Y or luminance components contained in a composite television signal which are in essence those components necessary and utilized for monochrome transmission as well.

In order to preserve the d.c. content contained in the composite signal for proper reproduction of the transmitted television scene, the luminance channel is usually direct coupled to the appropriate electrodes of the kinescope. In this manner a change in the bias or d.c. operating point of the luminance amplifier changes the bias to the appropriate kinescope electrode and hence the brightness or background quality of the black and white displayed information.

Of course, the brightness qualities of a color display are also affected by the d.c.

bias control due to the nature of the presentation of color images. These are produced by the suitable mixing of those luminance components with color information signals processed by the receiver and also contained in the composite signal. Basically in order to enable the viewer to obtain a pleasurable display containing a desired amount of light intensity from a color television receiver, the kinescope employed therein is caused to operate with relatively high potentials on its electrodes (as ultor, screen and focus electrodes) which result in fairly high beam currents. This results in a relatively high power dissipation for the kinescope which thereby requires well designed high voltage power supplies and associated circuitry.

However, the desire to obtain television displays with high or large light intensity levels may further present other problems when the operating conditions for the kinescope are exceeded due to the aging of components, power supply or line changes and so on. Hence it becomes necessary to limit the amount of drive available to the kinescope when a number of adverse situations arise. The requirements of high voltage and high current, if maintained within safe limits can produce a desired picture without difficulty or damage to the kinescope and within safe commercial standards. However, if for some reason the levels go beyond those safe operating levels or as the voltage or current goes higher, such conditions could result in excessive X-ray generation or radiation by the kinescope circuitry of the receiver.

Furthermore, excessive levels of operation may result in over dissipation of the kinescope itself, hence shortening of its life and leading to its eventual destruction. Also, while the kinescope may be capable of limited periods of operation at such excessive levels without destruction or damage thereto, such conditions may result in loading the high voltage supply furnishing power to the kinescope, which will result in a degradation of the deflection system, the linearity of the scan, a change or adverse effect on

the size of the raster, a blooming, as going brighter and darker with changes in scene content, a change in the effective beam diameter resulting from improper focusing control and so on. Thus an adverse loading of the high voltage supply driving the kinescope can very well cause the television receiver employing the kinescope to produce a display which is totally unacceptable or incapable of being enjoyably viewed.

Accordingly, it is an object of the present invention to provide a circuit for limiting the amount of drive to a kinescope employed in a television receiver within a safe area of operation.

According to a preferred embodiment of the present invention a circuit operates to control the bias on a video chain or luminance amplifier which is direct coupled to the cathode electrodes of a kinescope. The circuit operates to automatically sense the total current flowing through the output winding of a transformer used in a high voltage supply. The sensing circuit serves to monitor this current with reference to a fixed level to assure that the total current supplied to the kinescope is within a safe operating region. During this operating mode the sensing circuit generates a regulated bias which serves to operate the video chain or luminance amplifier at a desired quiescent point. Brightness control, during this mode defining safe operation, is available to the consumer by means of a potentiometer coupled to the video amplifier and effective to manually change the d.c. quiescent operating points. If for any reason the total current supplied to the kinescope increases beyond a predetermined safe level, the sensing circuit detects this and operates to remove regulation of the bias supplied to the video chain or luminance amplifier, which is now subjected to a bias voltage changing in proportion to the total current drawn by the kinescope and in a direction to counteract this increase in current. This is accomplished by increasing the bias between the grid and cathode electrodes of the kinescope thus forcing the kinescope towards cutoff. During this mode a large loop gain is afforded by the sensing circuit, which gain is great enough to counteract or try to defeat any attempt by the consumer to further increase the brightness capability of the picture by means of the above described potentiometer.

The accompanying Figure is a schematic diagram partially in block form of a color television receiver showing a circuit incorporating the principles of the present invention.

Referring to the Figure, an antenna 10 receives radio frequency television signals. Television signal receiver 11 coupled to antenna 10 serves to further process these

signals by converting the radio frequency signal to intermediate frequency or I.F. signals by means of conventional and known techniques. Such techniques may employ a mixer and a local oscillator together with suitable stages of amplification to obtain the television intermediate frequency. A video detector 12 has its input coupled to the output of the television signal receiver 11 and contains a diode circuit arranged in a detector configuration which is responsive to the I.F. signals to derive therefrom a composite television signal.

A sound demodulator channel 13 is also coupled to the output of the television signal receiver and serves to detect the frequency modulated sound carrier and sidebands thereof to provide a signal representative of the audio transmitted for application to the speaker 14.

An output of the video detector 12 is coupled to the base electrode of a transistor 15 arranged in a common collector or emitter follower configuration. A voltage divider comprising resistors 16 and 17 is coupled between a reference voltage designated as $+V_A$ and a point of reference potential such as ground. The junction formed by resistors 16 and 17 is shown coupled to an input of the video detector 12 for biasing or referencing the detector to a selected d.c. level. This bias also serves to bias the base electrode of transistor 15.

The emitter electrode of transistor 15 is coupled to ground through a resistor 19 while the collector electrode is returned to a source of potential designated as $+V_{cc}$ through a decoupling resistor 31 bypassed by capacitor 32. The emitter electrode of transistor 15 presents a low impedance driving source and as such is coupled to one terminal of a series network comprising resistor 18, delay line 20, inductor 21 and resistor 22 respectively. The other terminal of this series network including resistor 22 is coupled to the emitter electrode of transistor 23 arranged in a common base configuration.

The emitter electrode of transistor 23 is returned to ground through a series combination of resistor 25, lead 26, resistors 24 and 28, and variable resistor 29. The junction between resistor 25 and lead 26 is bypassed to ground for high frequency a.c. signals by capacitor 33. The junction between resistors 24 and 28 is returned to ground for a.c. signals through capacitor 34.

Transistor 23 receives its bias via resistor 27 having one terminal connected to the base electrode of transistor 23 and its other terminal coupled to the junction between the emitter electrode of a transistor 40 and one terminal of a voltage divider, comprising variable resistor 41 in series with resistor

44. Resistor 44 has a terminal connected to a $+V_R$ reference supply.

The collector electrode of transistor 40 is returned to ground through a load resistor 45. Base bias is supplied to a transistor 40 by means of a voltage divider comprising resistors 42 and 43 coupled between the $+V_R$ supply and a point of reference potential. The junction formed thereby being connected to the base electrode of transistor 40. As will be explained subsequently, transistor 40, supplying bias to the base electrode of transistor 23, serves together with the high voltage supply and associated circuitry to control the level of the d.c. coupled to the electrodes of the kinescope by operating on transistor 23.

The base electrode of transistor 23 is bypassed to ground for signal frequencies by means of capacitor 29¹. The collector electrode of transistor 23 is coupled through a resistor 30 to the decoupled point emanating from the $+V_{cc}$ supply.

A transistor 50 in a common emitter configuration has its base electrode coupled to the collector electrode of transistor 23 via resistor 51. The collector electrode of transistor 50 is coupled to the point of reference potential through a resistor 52. The emitter electrode of transistor 50 is coupled through a resistor 53 to the decoupled $+V_{cc}$ supply and is bypassed by a capacitor 54. A further transistor 55 is arranged in a common collector configuration having a collector electrode returned to the decoupled point of the $+V_{cc}$ supply, and the emitter electrode of transistor 55 is referenced to ground through a resistor 56. Bias and drive for transistor 55 is obtained by coupling the base electrode to the collector electrode of transistor 50.

A feedback network comprising the series connection of resistors 57 and 58 is coupled between the emitter electrode of transistor 55 and the emitter electrode of transistor 23. The junction between resistors 57 and 58 is returned to ground through a series path comprising capacitor 59, inductor 60, and variable resistor 61. These components supply negative feedback to the overall amplifier configuration comprising transistors 23, 50 and 55. The luminance amplifier, just described, having a signal output represented by the emitter electrode of transistor 55, supplies video signals to the input of a video driver circuit 62 utilized to supply relatively large luminance signals to the appropriate electrodes, such as the cathodes, of a color kinescope 63 which may, for example, be a three-gun shadow mask tube.

Also present in a color television receiver is a deflection and sync circuit 69 and a chroma channel 49. A conventional color television receiver may also include automatic gain control circuitry, automatic

chroma control circuitry and so on which are not shown or necessary for the explanation of the present invention.

The inputs to the deflection and sync circuits 69 and the chroma channel 49 are supplied by the low impedance output at the emitter electrode of transistor 15. The function of the sync circuit, included within rectangle 69, is to operate on the composite video signals present at its input to retrieve the synchronizing components therefrom, necessary to assure proper presentation of the television signal display. The synchronizing circuits in turn supply an output to the input of the deflection circuits also included within rectangle 69.

The deflection circuits serve to generate synchronized horizontal and vertical drive waveshapes for deflecting the electron beams of the color kinescope 63 which action is necessary to provide a raster. Accordingly two outputs from the deflection and sync circuit 53 are shown coupled to a yoke 64 associated with the kinescope 63 for deflecting the electron beams both horizontally and vertically under the control of the waveforms generated in rectangle 69. The high voltage necessary to operate the kinescope 63 is derived by the rectification of appropriate flyback pulses generated by the action of the deflection circuits included in rectangle 69.

For this purpose the primary winding of a flyback transformer 65 is shown coupled between an output of the deflection circuits 69 and a point of reference potential such as ground. The secondary winding of transformer 65 has a plurality of taps selected at suitable points thereon. A high voltage tap has a terminal connected to the anode of a high voltage rectifier 66 whose cathode is coupled to the ultor or second anode electrode of the kinescope 63. The high voltage rectifying diode 66 serves to rectify the flyback pulses to produce a potential at the ultor electrode which is filtered by the capacitance of the ultor to obtain thereat a d.c. level which may, for example, be of the order of magnitude of 25KV.

A second lower voltage tap of the secondary of transformer 65 is coupled through a capacitor 67 to the input of focus supply 68 whose output is coupled to suitable focusing electrodes associated with kinescope 63. The focus supply 68 serves to rectify flyback pulses to provide a suitable focusing potential for the kinescope 63. This potential, being applied to the appropriate electrodes of the kinescope, maintains the electron beams within a well defined diameter.

A third still lower voltage tap on the secondary winding of transformer 65 is coupled through a half wave rectifying circuit comprising diode 70 having its anode coupled to said tap, and its cathode coupled

through a resistor 71 to a terminal of a filtering capacitor 72 having the other terminal coupled to ground. The conventional half wave rectifier circuit shown, produces a positive voltage for application to the screen control circuits 73 having outputs coupled to the screen electrodes of the kinescope 63. The screen control circuits together with the voltage impressed thereon are necessary to assure that the kinescope 63 will operate at suitable electron beam current levels necessary to supply a good quality display.

A return path for the secondary winding of transformer 65 is provided by means of resistor 75 coupled between the lower terminal of the secondary winding and the emitter electrode of transistor 40. Resistor 75 also serves to form part of a filter with capacitors 76 and 77, each coupled between a respective terminal of said resistor and a point of reference potential such as ground.

The chroma channel 49 functions to retrieve and process the color information present in the composite signal within the bandwidth associated with such information. The chroma channel, as shown herein, also includes a burst amplifier and subcarrier oscillator. The burst amplifier serves to retrieve burst information present in the composite signal at the back porch of the horizontal synchronizing pulses. The retrieved bursts are utilized to synchronize a subcarrier oscillator operating at the color subcarrier frequency. The output of the chrominance channel 49 containing chroma information and the oscillator output are applied to inputs of color demodulators 80.

The function of the color demodulators 80 is to synchronously demodulate the chrominance information using respective appropriate phased outputs of the color oscillator as a standard. In this manner color difference signals are provided at the outputs of the color demodulators for coupling to the appropriate electrodes of the kinescope 63.

The operation of the above described circuit which embodies the principles of the present invention will now be described in greater detail.

Video signals provided by detector 12 are coupled to the base of the emitter follower 15 which provides a high impedance to the detector to avoid loading the same. The output of emitter circuit of transistor 15 provides a relatively low driving impedance. The current drive capabilities of this stage are then used to drive the deflection and sync circuits 69, the chroma channel 49 while further providing a low output impedance for coupling to the input of delay line 20.

Transistor 23 is a common base stage whose emitter electrode provides a low im-

pedance. Resistors 18 and 22 coupled in series with the delay line are selected according to the characteristic impedance of the delay line 20 and are of a magnitude comparable with said impedance. In this manner delay line 20 is properly terminated both at its input and output terminals, thus minimizing transient ringing which would otherwise occur due to mismatch between the characteristic impedance of the delay line and its terminations.

The common base stage 23 by means of its collector circuit furnishes drive to the common emitter stage including transistor 50 to provide the necessary voltage gain and polarity signal information required. The collector load of transistor 50 is coupled to a second emitter follower comprising in part transistor 55 necessary to drive the output video driver stage 62 from a low impedance source.

The luminance amplifier just described has a feedback network comprising resistors 57 and 58 which serve to maintain bandwidth and stabilize the d.c. operating points or bias levels of the luminance amplifier. Disregarding the effects of capacitor 59, inductor 60 and variable resistor 61, the amplifier is tailored to give an amplifier response which begins to fall off at approximately 1.5 MHz and, produces a gain of $\frac{1}{2}$ the midband gain at a frequency of about 3.08 MHz (for United States standards). This response is essentially the response at the output of the video detector 12, rolled off to some degree, to provide an amplifier characteristic that has some inherent depeaking and has relatively low 3.58 MHz chroma subcarrier response. The low gain chroma subcarrier response is necessary to prevent excessive dot patterns from appearing on the face of the kinescope 63.

Except for the effects of various distributed capacitance the gain of the system is essentially kept broadband by the feedback current supplied through resistors 57 and 58.

The series network comprising capacitor 59, inductor 60 and variable resistor 61 combine to form a series resonant circuit at about 1.5 MHz. This circuit will provide peaking of the frequency response around the above noted resonant frequency (1.5 MHz) by reducing the feedback at this point. As can be seen from the circuit the series network has an impedance near the resonant frequency which approaches the magnitude of resistor 61.

Accordingly, if resistor 61 was short-circuited the branch impedance of this series circuit would be negligible compared to the magnitude of resistors 57 and 58 at the frequency of 1.5 MHz. This condition would permit no feedback signal for frequencies surrounding this frequency point

to be coupled back to the input of transistor 23 thereby increasing the amplifier gain. The amount of peaking present in the response is a function of the Q or quality factor of this network and the frequency of resonance.

Due to the relative isolation provided by resistors 57 and 58 the amount of peaking is relatively independent of variations in the impedances between the emitter electrode of transistor 23 and ground, and the emitter electrode of transistor 55 and ground. In this manner the frequency response of the amplifier at maximum peaking, which corresponds to shorting out resistor 61, can be made to have approximately a 40% higher gain at 1.5 MHz than at the mid-band range of luminance signals. With this setting of resistor 61 the gain at approximately 3 MHz will be about 30% of the gain at 1.5 MHz, and the color subcarrier frequency (3.58 MHz) will be further attenuated by a factor of over 10% when compared to the response of the amplifier substantially corresponding to the omission of the series network or maximum resistance of resistors 61.

The above described circuit as seen from the Figure is direct coupled for video signals to the cathodes of the kinescope 63. Direct coupling of the luminance is desired to preserve the d.c. components present in the composite video signal for application to the kinescope electrodes in order to produce a display corresponding in correct brightness levels for the transmitted picture. Accordingly, a change in d.c. or a change in the operating points of the video amplifier stages described above, as comprising transistors 15, 23, 50 or 55, results in a change in the d.c. level applied to the cathodes of the kinescope 63. Such a change, in turn, affects the bias between the cathodes and the grid electrodes of the kinescope 63 and hence may serve to lower or raise the kinescope beam current and thereby affect the brightness of light intensity of the display.

The brightness control comprising variable resistor 29 which is coupled to the emitter electrode of transistor 23 through the series network of resistors 25, 24 and 28 serves to change the d.c. potential at the emitter and therefore the collector electrode of transistor 23. Accordingly, the d.c. voltage coupled to the kinescope electrodes can be designated as a brightness control. Usually the brightness control 29, is located on the front panel of the receiver and is made available for control by the consumer or viewer. In order to accomplish this, a cable 26 must be routed from the luminance amplifier board or chassis circuit location to the front panel, and as

such the length of the cable 26 may be quite substantial.

Because of the frequencies encompassed within the luminance bandwidth such a length of cable may behave as a delay line. If this delay line 26 were only terminated by the brightness control 29, which would be the case if resistors 24 and 28 and capacitor 34 were omitted, the termination would vary according to the setting of the brightness control 29. In this manner, the cable 26 behaving as a delay line, would cause signals of certain frequencies appearing at the emitter electrode of transistor 23, either due to the feedback network or to the video input thereto, to couple through the delay line 26 and be reflected back again to the input at the emitter electrode of transistor 23. This would cause a poor transient response in the luminance channel for certain signal frequencies not sufficiently bypassed by capacitor 33.

In order to avoid this, resistor 24 is selected to provide a limiting termination for cable 26 at such frequencies. A terminal of resistor 24 is then coupled to the output of the delay line while the other terminal is bypassed to ground for all luminance frequencies by means of capacitor 34. In this manner the delay line 26 sees a fixed terminating impedance of a magnitude equal to resistor 24 for all a.c. signals within the luminance band.

Capacitor 34 further serves in combination with resistors 28 to bypass potentiometer noise generated by metal-to-metal contact due to the nature and construction of variable resistors as 29 presently utilized in conventional television receivers. Resistor 28 has one terminal coupled to the junction between capacitor 34 and resistor 24 and the other terminal in series with the brightness control 29.

Resistor 28 assures that a fixed impedance is also in the circuit to always provide an R.C. network to eliminate such potentiometer noise independent of the setting of resistor 29. In the above described manner, resistor 29 serves to control the d.c. voltage at the emitter electrode and hence at the collector electrode of transistor 23 without having its setting effectively degrading the magnitude of the a.c. signals or otherwise affecting the a.c. characteristics of the luminance amplifier described.

In well designed color television sets, it is desired to operate the kinescope at fairly large beam currents and higher voltage levels to produce a good quality display evidenced, in part, by suitable brightness levels. However, it is also necessary to prevent driving the kinescope so hard that the safe dissipation characteristics of the kinescope are exceeded.

Furthermore excessive drive even within

the capacity of the kinescope may result in an excessive amount of X-ray radiation emanating from the color television receiver due to the high voltage and high currents. Furthermore the high voltage supply if optimally utilized will begin to overload before the limiting point of the kinescope is reached which will cause degradation in the overall picture. Such picture degradation results from a plurality of factors, such as change in the deflection sensitivity, blooming or loss of focus, loss of horizontal linearity and an overall degradation in the size of the raster.

This invention includes circuitry sufficient to limit the maximum amount of bias on the video amplifier chain at a point where the maximum capability of the kinescope is reached with regard to the above described factors. The operation of the circuit is as follows:

Initially assume that the current drawn through capacitor 67, connected to a high voltage tap on the secondary winding of transformer 65, and the current drawn by the half wave rectifier circuit, comprising, in part, diode 70 connected to a third tap on the secondary winding of transformer 65, are both zero. In addition, assume that the kinescope 63 is cutoff which might correspond to the maximum resistance setting of resistor 29.

Under these conditions the magnitude of the current through the high voltage rectifier tube 68 will be small being due only to kinescope leakage in this cutoff condition. With these assumptions the current flowing through resistor 75 will be approximately zero (or kinescope leakage current) since this current is equal to the sum of the above three currents.

Under these conditions, transistor 40 is biased on and current is conducted from the $+V_R$ reference supply through resistors 41 and 44 via the emitter-to-collector path of transistor 40 through resistor 45 to ground. The $+V_R$ reference supply in conjunction with resistors 41 and 44 form a stable current generating means. The amount of current drawn for the above conditions depends on the setting of resistor 41 which may be designated as a brightness limiter threshold adjustment. Under optimum operating conditions resistor 41 is adjusted such that the current flowing through the collector-to-emitter path of transistor 40 to ground is equal to the amount of current at the limiting threshold of the kinescope or the maximum current through the high voltage rectifier 66.

Resistors 42 and 43 are chosen such that the voltage at the base of transistor 40 plus the voltage drop from the base-to-emitter of transistor 40 is the desired bias voltage for transistor 23. The base electrode of transistor 23 is coupled to the emitter elec-

trode of transistor 40 via resistor 27. As long as transistor 40 is conducting, the voltage at its emitter electrode is relatively constant due to the selection of resistors 42 and 43 and as further being referenced to the stable supply $+V_R$.

Assume now that the resistance of the brightness control 29 is decreased, that is the brightness control may be so turned by the user. This action decreases the d.c. voltage available at the emitter electrode of transistor 23 and serves to bias this stage in a direction to cause increasing conduction. This causes the collector electrode of transistor 23 to go negative which in turn causes the collector electrode or transistor 50 to go more positive. In turn, the emitter of transistor 55 goes more positive which serves to increase the d.c. voltage by means of video amplifier driver 62 at the cathodes of the kinescope 63, causing the kinescope to conduct harder.

The increase in conduction corresponds to turning the kinescope on and causes the ultor electrode of the kinescope to draw current through diode 66. As this current increases the current through resistor 75 increases correspondingly. The current through resistors 41 and 44 is relatively constant and is equal to the sum of the current through resistor 75, plus the current through the collector-to-emitter path of transistor 40. Since the current through resistors 41 and 44 is constant and since the current through resistor 75 increased, the current through transistor 40 must decrease.

However, the voltage at the emitter of transistor 40 remains relatively constant, as long as transistor 40 is conducting, since it is dependent upon the voltage at the base electrode and the base-to-emitter drop. This voltage then is well regulated as long as transistor 40 is conducting.

If the drive to the kinescope continues to increase the current through resistor 75 will increase as well, as will the current supplied to the ultor electrode of the kinescope 63. This will cause current through the collector-to-emitter path of transistor 40 to approach zero. The voltage at the emitter electrode of transistor 40 will at this point decrease, due to the fact that transistor 40 switches off, i.e. goes to cutoff, and hence the voltage at its base electrode becomes more positive than the voltage at its emitter.

Under these conditions if the television set viewer further desires to decrease resistor 29, which will tend to bias transistor 23 in a more conductive state, this attempt will be counteracted by a decrease in the voltage at the emitter electrode of transistor 40 for two reasons. First, transistor 40 is cutoff, thus there is no regulation of voltage at the emitter electrode and therefore at the base of transistor 23. Secondly, there is an in-

crease in the current to the kinescope 63 via the high voltage rectifier 66 which serves to produce a larger voltage drop across resistors 41 and 44, thus forcing the base of transistor 23 towards ground or to follow these current variations.

The degree of limiting afforded by this circuit is in part determined by the cutoff characteristics of transistor 40, which may be very sharp, and the overall large loop gain of the system when transistor 40 is cutoff. In the normal case the currents flowing through the diode 70 to the screen electrodes of the kinescope, and that current through capacitor 67 to the focus electrodes of the kinescope are not zero, but as can be seen, the combined magnitude of these currents serves to add a constant current through resistors 44, 41, 75 and the secondary winding taps associated with the focus and screen supplies. This constant current is independent of the kinescope used with a given chassis and will be dependent only upon the values of the components associated with the high voltage supplies for that chassis. In this manner the limiting threshold, as adjusted by resistor 41, can be set up to compensate for any loss of current through transistor 40 due to the quiescent and dynamic values of the kinescope screen and focus electrode currents.

The circuit further includes arc protection particularly with respect to high voltage arcs which may occur across the high voltage rectifier tube 66. Such arcs will tend to transfer the energy stored in the capacitance associated with the ultor electrode of the kinescope back into the circuit, comprising in part, transistor 40. These arcs are capable of producing back currents through resistor 75 of one or two amperes. To enable the circuit to accept this energy without damage to the transistor 40 or to the other components, capacitor 77 and resistor 45 have been included. In this manner resistor 45 limits the current handling capability of transistor 40 so as to prevent damage to the transistor. Capacitor 77 provides a means of storing charge or filtering these current surges and hence prevent them from affecting the voltage at the emitter electrode of transistor 40. A circuit embodying the principles of the above described invention was built and operated using the following components:

Transistor 15	SE1002
Transistor 23	2N3694
Transistor 50	2N4121
Transistor 55	2N3643
Transistor 40	1473581-1
Resistor 16	2190 ohms
Resistor 17	390 ohms
Resistor 18	560 ohms
Resistor 19	1,000 ohms

Resistor 22	680 ohms	65
Resistor 24	10 ohms	
Resistor 25	470 ohms	
Resistor 27	470 ohms	
Resistor 28	100 ohms	
Resistor 29	20,000 (variable)	70
Resistor 30	330 ohms	
Resistor 31	10 ohms	
Resistor 41	2,500 (variable)	
Resistor 42	2,000 ohms	
Resistor 43	560 ohms	75
Resistor 44	2,700 ohms	
Resistor 45	100 ohms	
Resistor 51	1,000 ohms	
Resistor 52	1,800 ohms	
Resistor 53	27 ohms	80
Resistor 56	1,800 ohms	
Resistor 57	4,700 ohms	
Resistor 58	3,900 ohms	
Resistor 61	20,000 (variable)	
Resistor 71	10,000 ohms (1 Watt)	85
Resistor 75	1,000 ohms	
Capacitor 29	10 microfarads	
Capacitor 33	.01 microfarads	
Capacitor 34	100 microfarads	
Capacitor 54	.0027 microfarads	90
Capacitor 32	.01 microfarads	
Capacitor 59	120 micromicrofarads	
Capacitor 67	470 micromicrofarads	
Capacitor 72	.02 microfarads	
Capacitor 76	.01 microfarads	95
Capacitor 77	50 microfarads	
Inductor 21	15 microhenries	
Delay Line	8 (680 ohms)	
Inductor 60	36 microhenries	
Diode 70	RCA #1476183-2	100
Rectifier 66	3CU3	
+V _{cc}	+30V	
+V _A	+15V	
+V _R	+15 volts zener	
+V _A =+V _R	regulated	105

WHAT WE CLAIM IS:—

1. A television receiver circuit for limiting the power dissipation of a kinescope of the receiver, said power dissipation determined in part by the bias on a beam current control electrode, said receiver circuit comprising a high voltage power supply circuit for supplying operating potentials to suitable other electrodes of said kinescope including an ultor electrode, monitoring means coupled to said high voltage supply circuit for providing an output current level indicative of the total current drawn by said high voltage supply, generating means for supplying a reference current having a magnitude indicative of a predetermined level of current capable of being safely drawn by said high voltage supply as operating said kinescope, and biasing means coupled to said control electrode of said kinescope, responsive to said reference current and said output current level indicative of said total current for changing the bias on said control electrode in a direction to decrease said

crease in the current to the kinescope 63 via the high voltage rectifier 66 which serves to produce a larger voltage drop across resistors 41 and 44, thus forcing the base of transistor 23 towards ground or to follow these current variations.

The degree of limiting afforded by this circuit is in part determined by the cutoff characteristics of transistor 40, which may be very sharp, and the overall large loop gain of the system when transistor 40 is cutoff. In the normal case the currents flowing through the diode 70 to the screen electrodes of the kinescope, and that current through capacitor 67 to the focus electrodes of the kinescope are not zero, but as can be seen, the combined magnitude of these currents serves to add a constant current through resistors 44, 41, 75 and the secondary winding taps associated with the focus and screen supplies. This constant current is independent of the kinescope used with a given chassis and will be dependent only upon the values of the components associated with the high voltage supplies for that chassis. In this manner the limiting threshold, as adjusted by resistor 41, can be set up to compensate for any loss of current through transistor 40 due to the quiescent and dynamic values of the kinescope screen and focus electrode currents.

The circuit further includes arc protection particularly with respect to high voltage arcs which may occur across the high voltage rectifier tube 66. Such arcs will tend to transfer the energy stored in the capacitance associated with the ultor electrode of the kinescope back into the circuit, comprising in part, transistor 40. These arcs are capable of producing back currents through resistor 75 of one or two amperes. To enable the circuit to accept this energy without damage to the transistor 40 or to the other components, capacitor 77 and resistor 45 have been included. In this manner resistor 45 limits the current handling capability of transistor 40 so as to prevent damage to the transistor. Capacitor 77 provides a means of storing charge or filtering these current surges and hence prevent them from affecting the voltage at the emitter electrode of transistor 40. A circuit embodying the principles of the above described invention was built and operated using the following components:

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Resistor 22	680 ohms	65
Resistor 24	10 ohms	
Resistor 25	470 ohms	
Resistor 27	470 ohms	
Resistor 28	100 ohms	
Resistor 29	20,000 (variable)	70
Resistor 30	330 ohms	
Resistor 31	10 ohms	
Resistor 41	2,500 (variable)	
Resistor 42	2,000 ohms	
Resistor 43	560 ohms	75
Resistor 44	2,700 ohms	
Resistor 45	100 ohms	
Resistor 51	1,000 ohms	
Resistor 52	1,800 ohms	
Resistor 53	27 ohms	80
Resistor 56	1,800 ohms	
Resistor 57	4,700 ohms	
Resistor 58	3,900 ohms	
Resistor 61	20,000 (variable)	
Resistor 71	10,000 ohms (1 Watt)	85
Resistor 75	1,000 ohms	
Capacitor 29	10 microfarads	
Capacitor 33	.01 microfarads	
Capacitor 34	100 microfarads	
Capacitor 54	.0027 microfarads	90
Capacitor 32	.01 microfarads	
Capacitor 59	120 micromicrofarads	
Capacitor 67	470 micromicrofarads	
Capacitor 72	.02 microfarads	
Capacitor 76	.01 microfarads	95
Capacitor 77	50 microfarads	
Inductor 21	15 microhenries	
Delay Line	8 (680 ohms)	
Inductor 60	36 microhenries	
Diode 70	RCA #1476183-2	100
Rectifier 66	3CU3	
+V _∞	+30V	
+V _A	+15V	
+V _R	+15 volts zener	
+V _A =+V _R	regulated	105

WHAT WE CLAIM IS:—

1. A television receiver circuit for limiting the power dissipation of a kinescope of the receiver, said power dissipation determined in part by the bias on a beam current control electrode, said receiver circuit comprising a high voltage power supply circuit for supplying operating potentials to suitable other electrodes of said kinescope including an ultor electrode, monitoring means coupled to said high voltage supply circuit for providing an output current level indicative of the total current drawn by said high voltage supply, generating means for supplying a reference current having a magnitude indicative of a predetermined level of current capable of being safely drawn by said high voltage supply as operating said kinescope, and biasing means coupled to said control electrode of said kinescope, responsive to said reference current and said output current level indicative of said total current for changing the bias on said control electrode in a direction to decrease said



total current drawn by said kinescope when said total current tends to exceed said predetermined level.

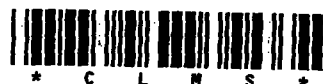
2. A television receiver circuit as claimed in Claim 1 wherein said kinescope has cathode and grid control electrodes with means for applying a relative potential therebetween, to determine, in part, the beam current drawn by said kinescope between its cathode and ultor electrodes, said monitoring means includes a transistor having a base, collector and emitter electrodes, and means coupling the collector-to-emitter path of said transistor in series with said high voltage supply for providing a current path therethrough, a voltage divider coupled to the base electrode of said transistor for maintaining the base electrode and therefore the emitter electrode of said transistor when conductive at a fixed regulated potential with respect to a reference potential, said reference current generating means being coupled to said collector-to-emitter path of said transistor and said reference current being distributed between said high voltage supply and said collector-to-emitter path of said transistor, said biasing means coupling the emitter electrode of said transistor to one of said control electrodes for biasing the same at said fixed regulated reference potential when a portion of said reference current flows through said collector-to-emitter path, and at a nonregulated potential when substantially all of said reference current flows through said high voltage supply corresponding to nonconduction of said transistor and said kinescope beam current increasing in a direction to exceed said maximum safe level, said nonregulated potential biasing said kinescope control electrode in a direction to counteract said beam current increase.

3. A television receiver circuit as claimed in claim 1 for color television, wherein said high voltage supply generates suitable operating potentials by the rectification of pulses obtained from deflection circuits included in said receiver, the receiver contains a luminance amplifier responsive to luminance information contained in a composite television signal, for amplifying the same and direct coupling said luminance information to said beam control electrodes of the kinescope to affect the brightness of a display caused to appear on a screen of said kinescope, said biasing means being coupled to said luminance amplifier for applying to said amplifier a first operating bias during a first mode in which said total operating current does not exceed said predetermined level and a second operating bias in a second mode in which said total operating current exceeds that level said bias in said second mode varying in proportion to said total operating current to change the d.c. level

appearing at said control electrodes of said kinescope via said luminance amplifier, in a direction to decrease the brightness of said display of said kinescope's screen, whereby said total operating current is reduced.

4. A television receiver circuit as claimed in Claim 3 wherein said electrodes of said kinescope include ultor, screen, and focus electrodes, and grid and cathode electrodes operative to control the magnitude of the kinescope beam current between said ultor and cathode electrodes, said receiver including a transformer responsive to deflection pulses for providing at a plurality of taps on a winding thereof different amplitude deflection pulse levels for application to rectifying circuits for providing operating potentials for said ultor, screen and focus electrodes, said amplified luminance information being direct coupled to said cathode electrode, said biasing means including a transistor, having its collector-to-emitter path coupled between said transformer winding and a point of reference potential, a reference voltage divider coupled to the base electrode of said transistor for applying a fixed predetermined bias thereto, the emitter electrode of said transistor being coupled to said luminance amplifier for biasing said amplifier at a current level normally determined by said bias voltage applied to said transistor's base electrode, and said reference current generating means being coupled to the junction of said collector-to-emitter path of said transistor and said winding for supplying to said winding and said collector-to-emitter path, reference current of a predetermined magnitude selected according to a predetermined kinescope beam current magnitude defining a safe limit of operation for said kinescope, such that when said beam current exceeds said safe limit all of said reference current is supplied to said winding to cause said transistor to cutoff, and said bias on said luminance amplifier, being no longer determined by said reference voltage, tends to vary with a resultant change of bias on said cathode electrode in a direction to decrease said beam current.

5. A television receiver circuit as claimed in claim 1 wherein said biasing means includes switching means having an input coupled to said monitoring means and said reference current generating means and an output coupled to a cathode electrode of said kinescope, for applying to said cathode electrode a bias determining the kinescope beam current when said total operating current is less than said predetermined level, and for applying to said cathode electrode, when said total operating current begins to exceed that level, a bias varying in a direction to decrease said beam current according to the magnitude of said total operating current.



6. A television receiver circuit as claimed in any preceding claim wherein said monitoring means includes a resistor in series with said high voltage supply, said resistor having an input and output terminal, first and second capacitors, said first capacitor being coupled between the junction of said high voltage supply and said resistor's input terminal and a point of reference potential, 10 said second capacitor coupled between said resistor's output terminal and a point of reference potential and forming with said resistor a filter network for said high voltage supply, said output terminal being 15 coupled to said biasing means.

7. A television receiver circuit as claimed in any preceding claim wherein said high

voltage supply includes a transformer having a primary and a secondary winding, said primary winding adapted to receive pulse signals from a deflection circuit, and said secondary winding having a plurality of taps each of which supplies "stepped up" voltage pulses for application to individual rectifying circuits associated with each tap. 20 25

8. A television receiver circuit substantially as hereinbefore described with reference to the accompanying drawing.

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