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[72] Inventor **Werner Franz Wedam**
Batavia, N.Y.

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[73] Assignee **Sylvania Electric Products Inc.**

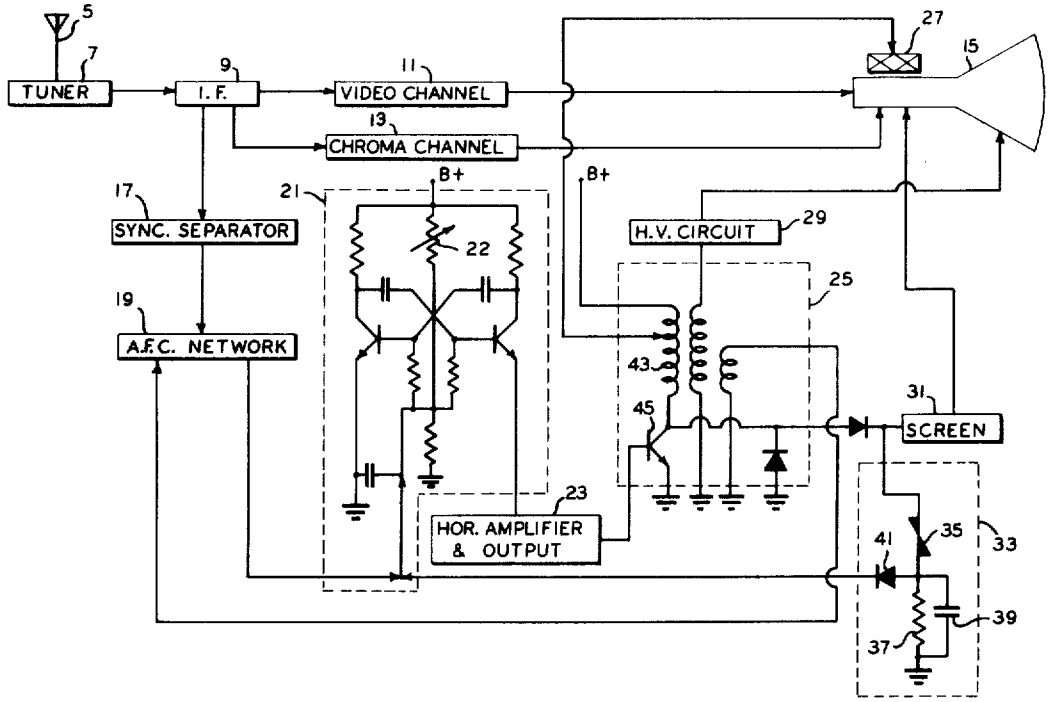
[54] **HIGH VOLTAGE PROTECTION CIRCUITRY**
10 Claims, 3 Drawing Figs.

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[51] Int. Cl. H01j 29/70
[50] Field of Search ..... 315/22; 178/DIG. 11, 7.5 R, 5.8 F

[56] **References Cited**
UNITED STATES PATENTS
3,440,481 4/1969 Rhee et al. 315/22

Primary Examiner—Rodney D. Bennett, Jr.
Assistant Examiner—H. A. Birmiel
Attorneys—Robert E. Walrath, Norman J. O'Malley and Thomas H. Buffton

ABSTRACT: Circuitry is provided for developing and applying control signals to a signal generator to alter the frequency of the signals therefrom causing reduction of high-voltage potentials and excessive distortion of scanning in an image display device in response to undesired increase in the high-voltage potentials applicable to the display device.



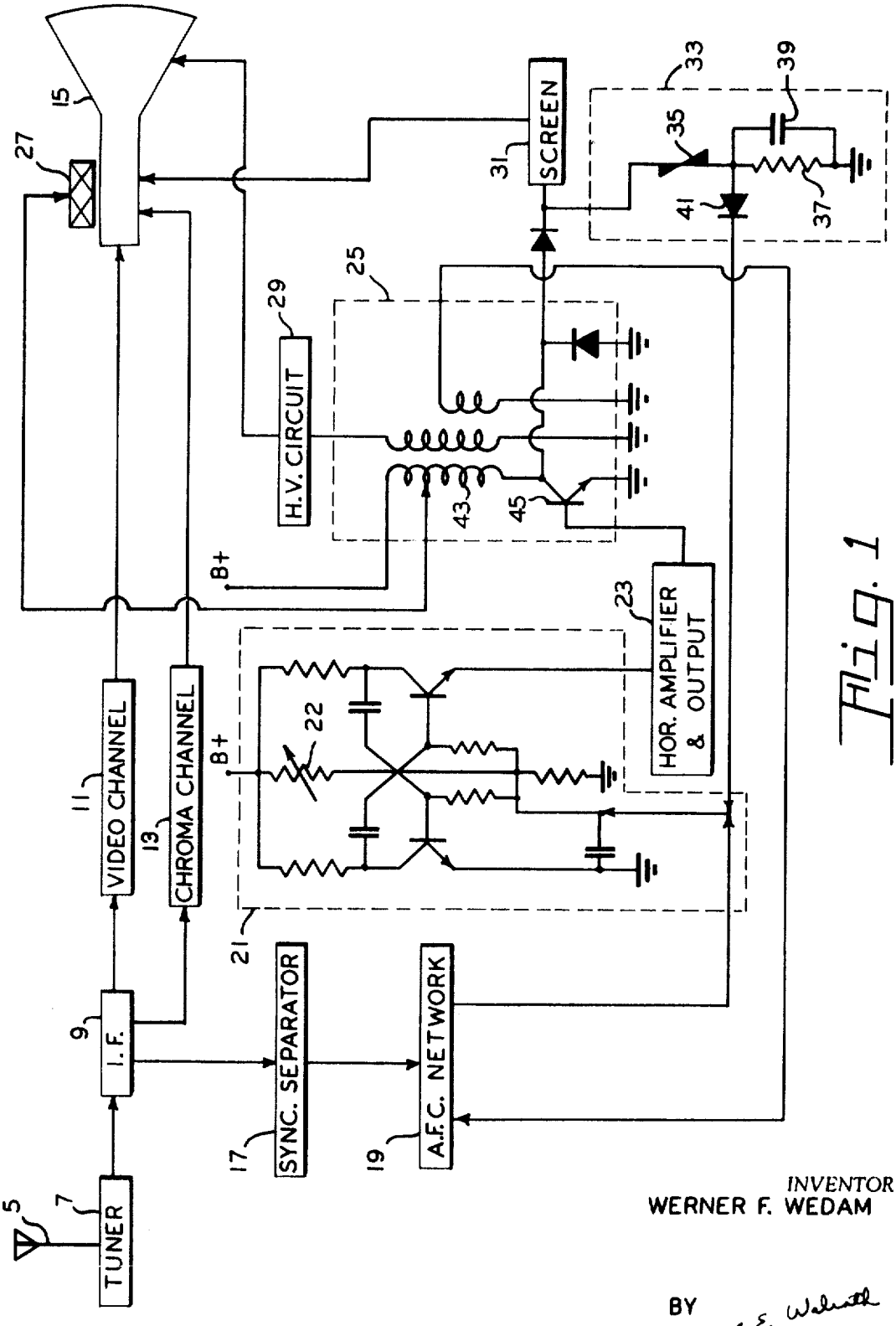


Fig. 1

INVENTOR.
WERNER F. WEDAM

BY Robert E. Walrath
ATTORNEY

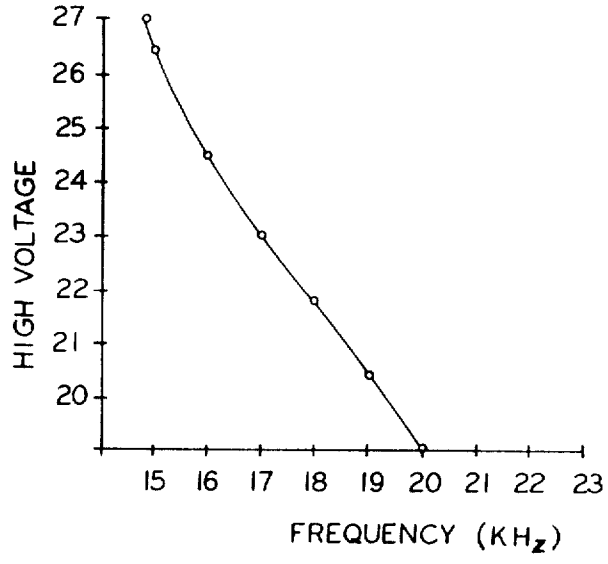


Fig. 2

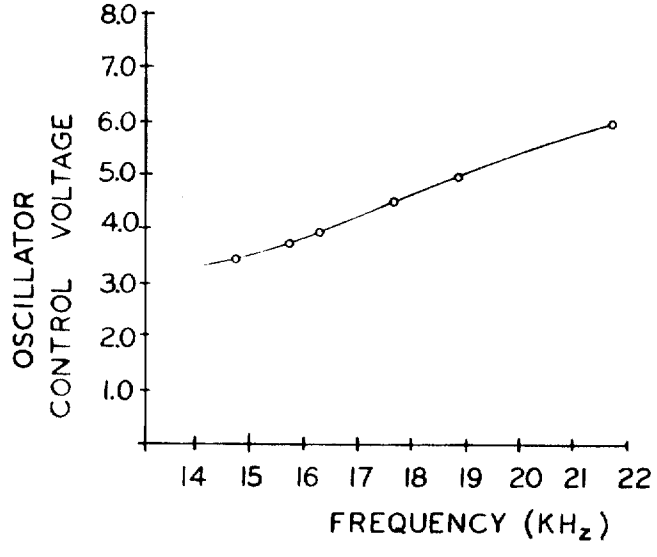


Fig. 3

INVENTOR.
WERNER F. WEDAM

BY Robert E. Walsh
ATTORNEY

HIGH VOLTAGE PROTECTION CIRCUITRY

BACKGROUND OF THE INVENTION

Cathode-ray tube systems and particularly television receiver type cathode-ray tube systems normally employ relatively high-voltage potentials. Moreover, such systems are subject to maladjustment, component failure, and shifts in component values such that the high-voltage undesirably increases which, in turn, has been determined to be deleterious due to the alleged X-ray radiation emanating from the apparatus.

One prior known form of protection apparatus for limiting the development of excessive high-voltage potentials and excessive X-ray radiation is disclosed in U.S. Pat. No. 3,440,481, issued to D. W. Rhee et al. on Apr. 22, 1969 and assigned to the assignee of the present application. Therein, a unidirectional conduction device is coupled in series with a shunt regulator tube whereby failure of the shunt regulator tube tending to cause an undersired increase in high-voltage potential is accompanied by an increase in bias applied to a current generator means. In turn, the current generator means tends to reduce the available high-voltage potentials and inhibit X-ray radiation.

However, the excellent results obtainable with such shunt regulator type systems tend to be limited due to the trend toward high-voltage systems wherein shunt regulators are not included. For instance, the known forms of tripler type high-voltage system wherein potentials are multiplied to provide a high-voltage potential no longer include shunt regulator tubes but do employ a relatively stable source of potential which is subject to maladjustment and variations due to shifts in component values.

OBJECTS AND SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide enhanced high-voltage protection circuitry for a cathode ray tube system. Another object of the invention is to alter the scanning frequency of a display device in an amount sufficient to distort the viewed scene in response to undesired increase in high-voltage potentials. Still another object of the invention is to disable the cathode-ray tube viewing system in response to either component failure or maladjustment of the high-voltage potentials. A further object of the invention is to provide high-voltage protection circuitry for cathode-ray tube high-voltage systems of a type other than the shunt regulator type.

These and other objects and advantages are achieved in one aspect of the invention by high-voltage protection circuitry which includes means for generating a signal coupled to a control potential means for effecting the generation of signals within a given range of frequencies, an output potential means for developing high-voltage and scanning voltage potentials coupled to the signal generating means, and a signal frequency control means responsive to variations in high-voltage to cause alteration in the control potentials applied to the signal generating means and development of signals at a frequency outside a given range of frequencies whereby the scanning voltages are altered deleteriously affecting scanning of an image display device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a television receiver, in block and schematic form, employing a preferred embodiment of the high-voltage protection circuitry of the invention;

FIG. 2 is a graph of developed high-voltage potentials and oscillator signal frequencies; and

FIG. 3 illustrates a graph of oscillator frequency and error voltage derived from a signal correcting means.

PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawing, a television receiver includes the usual antenna 5 coupled to a tuner 7 having the normal RF amplifier and detector stages. The tuner 7 provides signals at an IF frequency which are applied to an IF amplifier stage 9. Output signals from the IF amplifier stage 9 are applied via a video channel 11 and a chroma channel 13 to a color image reproducer or cathode-ray tube 15.

Another output signal from the IF amplifier stage 9 is applied to a synchronizing pulse separation stage 17 wherein synchronizing pulse signals are separated from the IF signals and applied to an automatic frequency control (AFC) network 19. The AFC network 19 develops a DC control potential, as will be explained hereinafter, which is applied to a signal generating stage 21.

The signal generating stage 21, normally referred to as the horizontal oscillator, includes a horizontal hold control 22 and develops signals within a given range of frequencies which are applied via an amplifier stage 23 to a horizontal output stage 25. The horizontal output stage 25 is coupled intermediate a potential source B+ and a potential reference level such as circuit ground and provides a plurality of output potentials.

The output stage 25 provides a first output potential which is applied to deflection apparatus 27 associated with the cathode-ray tube 15 to effect scanning thereof by an electron beam in a manner well known in the art. A second output potential is applied to high-voltage circuitry 29 wherein high-voltage potentials are derived and applied to the high-voltage electrode of the cathode-ray tube 15. A third output potential, directly related to the high-voltage potential, is applied to screen voltage circuitry 31 and then to the screen grid electrodes of the cathode-ray tube 15.

A fourth output potential available from the output stage 25 is coupled back to the previously mentioned AFC network 19. Therein, the output potential from the output stage 25 and the synchronizing pulse signals from the synchronizing pulse separation stage 17 are compared and a DC control potential representative of the difference in frequency therebetween is applied to the oscillator stage 21 to effect a shift in frequency thereof. In this manner, control signals from the AFC network 19 serve to continuously alter the operational frequency of the oscillator stage 21 such that the signals developed thereby tend to approach the frequency of the received synchronizing pulse signals.

Also, high-voltage related potentials available from the output stage 25 are coupled to the signal frequency control circuitry 33 wherein is provided a control voltage which is applied to the oscillator stage 21. Thus, an undersired shift in high-voltage potential causes a similar shift in high-voltage related potential which causes development of a control voltage in the signal frequency control circuitry 33 and application of this control voltage to the oscillator stage 21. In turn, the control voltage shifts the frequency of the signals generated by the oscillator stage 21 in an amount sufficient to affect the first output potential applied to the deflection apparatus 27. The altered potential applied to the deflection apparatus 27 is in an amount sufficient to cause distortion of the scanning of the cathode-ray tube 15 which indicates to the viewer an undesired increase in high-voltage potential and renders the receiver unusable due to the scan distortion.

More specifically the embodiment illustrated in FIG. 1 includes a signal frequency control circuit 33 having a voltage dependent resistor 35 and a resistor 37 shunted by a capacitor 39 series coupled intermediate the junction of the output stage 25 and screen voltage circuitry 31 and a potential reference level such as circuit ground. A unidirectional conduction device 41, such as a diode, couples the junction of series connected voltage dependent resistor 35 and resistor 37 to the base of the horizontal oscillator stage 21.

As to operation, it may be noted that the output stage 25 includes an inductor winding 43 and transistor 45 series connected intermediate the potential source B+ and a potential reference level such as circuit ground. The transistor 45 is coupled to the horizontal amplifier stage 23 which is coupled to the horizontal oscillator stage 21. The transistor 45 responds in a switchlike manner to signals from the amplifier stage 23 to effect intermittent current flow in the transistor 45 and inductor winding 43.

As is well known, the potential E*p* developed across the inductor winding **43** is equal to the product of the inductance "L" of the inductor winding **43** and the rate of change of current flow with time *di/dt*. Since the value of the inductance "L" of the inductor winding **43** is fixed and the time change *dt* is dependent upon the value of the inductance and capacitance of the circuitry, which remains essentially fixed, the developed potential E *p* varies in accordance with the current change *di*.

As mentioned above, the transistor **45** operates in a switchlike manner to signals from the amplifier stage **23** derived from the oscillator stage **21** to provide a given current change *di* which is dependent upon the frequency of the signals from the oscillator stage **21**. Thus, relatively low-frequency signals from the amplifier stage **23** cause longer closure of the switchlike transistor **45** providing an increased value of peak current in the inductor "L" and an increased value of high-voltage potential. Oppositely, relatively high-frequency signals from the oscillator stage **21** cause shorter closure of the switchlike transistor **45** providing less peak current and a reduced value of high-voltage potential.

This high-voltage potential-frequency relationship is illustrated in the chart of FIG. **2**. As can be seen, the high-voltage potential available from the high-voltage circuitry **29** is dependent upon the output stage **25**. In turn, the potential provided by the output state **25** varies inversely with the frequency of the signals applied thereto from the amplifier stage **23** and the oscillator stage **21**.

Normally, the oscillator stage **21** is designed for free-running operation at a frequency of about 15,750 cycles which is the assigned transmission frequency of the synchronizing pulse signals. This free-running frequency is adjustable within a range of about 300 cycles by means of the alterable horizontal hold control **22**. The AFC network **19** responds to any deviation in frequency between the output of the oscillator stage **21** and the receiver synchronizing pulse signals to cause application of a DC oscillator control potential to the oscillator stage **21** which tends to reduce the above-mentioned deviation in frequency between the oscillator signals and synchronizing pulse signals.

However, it can readily be seen that a variation in potential available from the potential source B+, a shift in frequency applied to the output stage **25**, component failure and numerous other undesirable conditions may cause a deleterious increased value of high-voltage potential applied to the display device **15**. In turn, the undesired increase in high-voltage potential may be accompanied by an undesired increase in X-ray radiation emanating from the apparatus.

Since the high-voltage related potential coupled to the signal frequency control circuitry **33** will vary in the manner of the high-voltage potential, the voltage applied to the series connected voltage dependent resistor **35** and resistor **37** will cause a variation in current flow therethrough and a variation in voltage drop thereacross. Moreover, the voltage drop developed at the junction of the VDR **35** and resistor **37** will be logarithmic in nature due to the response characteristics of the VDR **35**.

As a result, the variations in potential applied to the series connected resistors **35** and **37** will appear as emphasized voltage variations which are applied to the isolating and threshold limiting diode **41**. When these emphasized voltage variations are below a given threshold level, the diode **41** serves to isolate the oscillator stage **21** and no discernible change therein is evident. When the emphasized voltage variations are above the given threshold level of the diode **41**, the diode **41** become forward biased into a conductive state whereupon an oscillator control voltage is applied to the base of the transistors of the oscillator stage **21**.

Upon attainment of this emphasized voltage variation in an amount sufficient to overcome the threshold level of the diode **41**, the oscillator control voltage applied to the oscillator stage **21** will be of an amount sufficient to defeat the effects of alterations of the hold control **22** and the AFC network **19**. As a result, the frequency of signals applied to the output stage **25** and to the deflection apparatus **27** will be such that the scanning of the display device **15** is adversely affected causing distortion of the viewed image. Moreover, the condition is uncorrectable by adjustment of controls normally available to a viewer.

As a specific example, but in no way to be construed as limiting, a television receiver having a high-voltage related potential of about 900 volts applied to the screen grid electrode of the cathode-ray tube **15** employed a voltage dependent resistor **35** which conducted a current of about 0.4 ma. when the resistor **37** had a value of 8.2k. ohms. Thus, an error voltage of about 3.28 volts appeared at the junction of the resistors **35** and **37**. Moreover, the high-voltage potential applied to the cathode-ray tube had a value of about 25KV and the oscillator stage **21** operated at a frequency of about 15,734 Hz.

However, increasing the high-voltage potential to about 28KV caused an increase in high-voltage related potential from 900V to about 1050V and an increase in current flow from about 0.4 ma. to about 1.0 ma. As a result, the error voltage at the junction of resistors **35** and **37** increased from 3.28V to about 8.2V which, as can be seen in the illustrative chart of FIG. **3** shifts the frequency of the oscillator stage **21** and the scanning of the cathode-ray tube **15** sufficiently to render an image appearing thereon inviewable.

Thus, there has been provided a unique high-voltage protection circuit suitable for employment in the cathode-ray tube system of a television receiver and having numerous advantages over prior known systems. The circuitry is inexpensive of components and apparatus and not only prohibits the development of undesired high-voltage potentials, but more importantly, renders the television receiver inoperable for viewing when the high-voltage potential is increased either purposefully or due to component failure. Thus, the consumer is protected from undue high-voltage potentials and from undesired X-ray radiation possibilities.

While there has been shown and described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

I claim:

1. In a television receiver employing a display device utilizing high voltage and scanning voltages, high-voltage protection circuitry comprising in combination:

signal generating means;

control potential developing and applying means coupled to said signal generating means to effect generation of signals within a given range of frequencies for proper scanning of said display device;

output potential means coupled to said signal generating means and intermediate a potential source and a potential reference level to effect development of said high voltage, high-voltage related, and scanning potentials for said display device; and

signal frequency control means coupling said output potential means to said control potential developing and applying means to affect alteration in said signals developed by said signal generating means to frequencies outside said given range of frequencies in response to variations in magnitude of said high voltage whereby undesired variations in high-voltage magnitude are by alternations in signal frequency in an amount sufficient to alter scanning of the display device.

2. The combination of claim 1 wherein said signal frequency control means includes a voltage dependent resistor and a resistor series coupled intermediate said output potential means and a potential reference level with the junction of said series connected voltage dependent resistor and resistor coupled to said control potential developing and applying means.

3. The combination of claim 1 wherein said signal frequency control means includes voltage dependent resistor and a re-

sistor series coupled intermediate said output potential means and a potential reference level and a unidirectional conduction device coupling the junction of said series connected voltage dependent resistor and resistor to said control potential developing and applying means.

4. The combination of claim 1 wherein said signal frequency control means is coupled and responsive to a high-voltage related potential of said output potential means for effecting alteration of said control potential developing and applying means and of said signals generated by said signal generating means, said generated signals being outside said given range of frequencies causing alteration in scanning of said display device.

5. The combination of claim 1 wherein said given range of frequencies is within about 300 cycles of the scanning frequency of the television receiver.

6. The combination of claim 1 wherein said television receiver includes a synchronizing pulse signal source and said control potential developing and applying means is coupled to and derives a control potential from said synchronizing pulse signal source and said output potential means.

7. In a television receiver which includes a synchronizing pulse signal source and employs a cathode-ray tube utilizing high-voltage and scanning voltages, high-voltage protection circuitry comprising in combination:

horizontal oscillator means;

horizontal output means coupled to said oscillator means for developing high voltage and high-voltage related potentials and scanning potentials within a given range of frequencies;

control potential developing and applying means coupled to said synchronizing pulse signal source and said horizontal output means to effect development of a control potential for controlling development of signals within said given range of frequencies by said horizontal oscillator means; and

signal frequency control means coupling said horizontal output means to said control potential developing and applying means to effect development of signals outside said given range of frequencies by said horizontal oscillator means in response to variations in said high-voltage potential of said horizontal output means whereby an increase in high-voltage potential causes a shift in scanning potentials distorting the scan of the cathode-ray tube.

8. The combination of claim 7 wherein said horizontal output means includes a high-voltage related potential source and said signal frequency control means includes a voltage dependent resistor and a resistor series coupling said source to a potential reference level and the junction of said voltage dependent resistor and resistor coupled to said control potential developing and applying means

9. The combination of claim 8 including a unidirectional conduction device coupling said junction of said series connected voltage dependent resistor and resistor to said control potential developing and applying means.

10. The combination of claim 8 including a capacitor shunting said resistor.