July 3, 1951 R. D. KELL 2,559,078

TELEVISION SYSTEM

Filed Aug. 10, 1946 2 Sheets-Sheet 1

Fig. 1

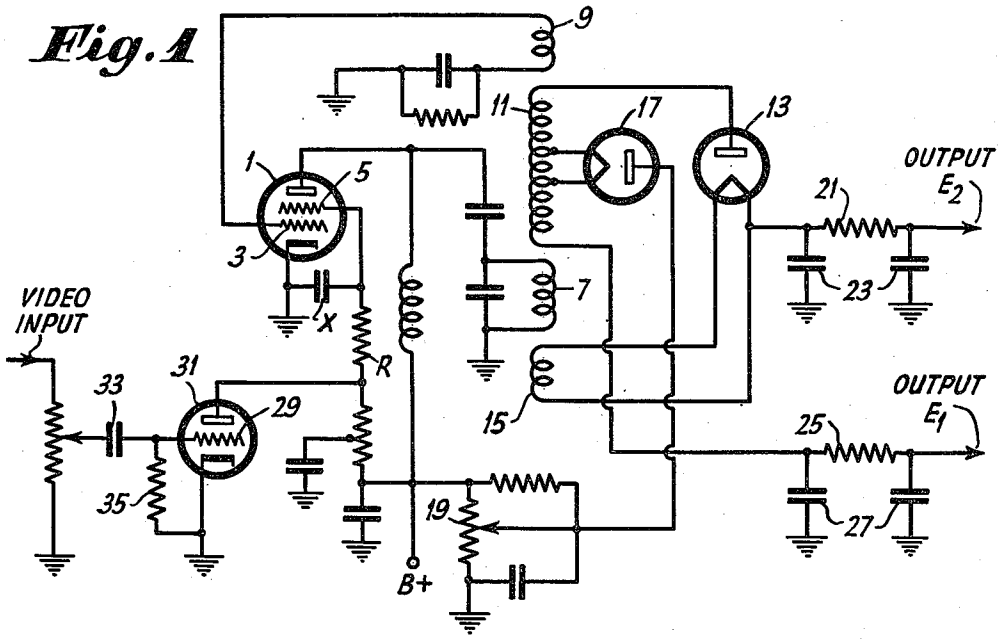
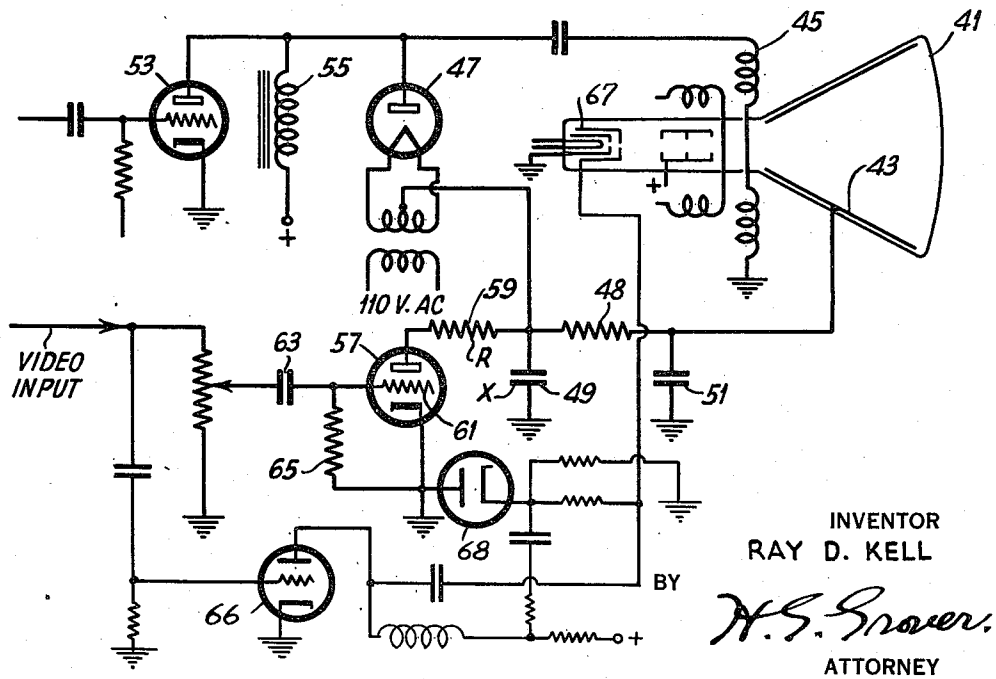


Fig. 2



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Filed Aug. 10, 1946 2 Sheets-Sheet 2

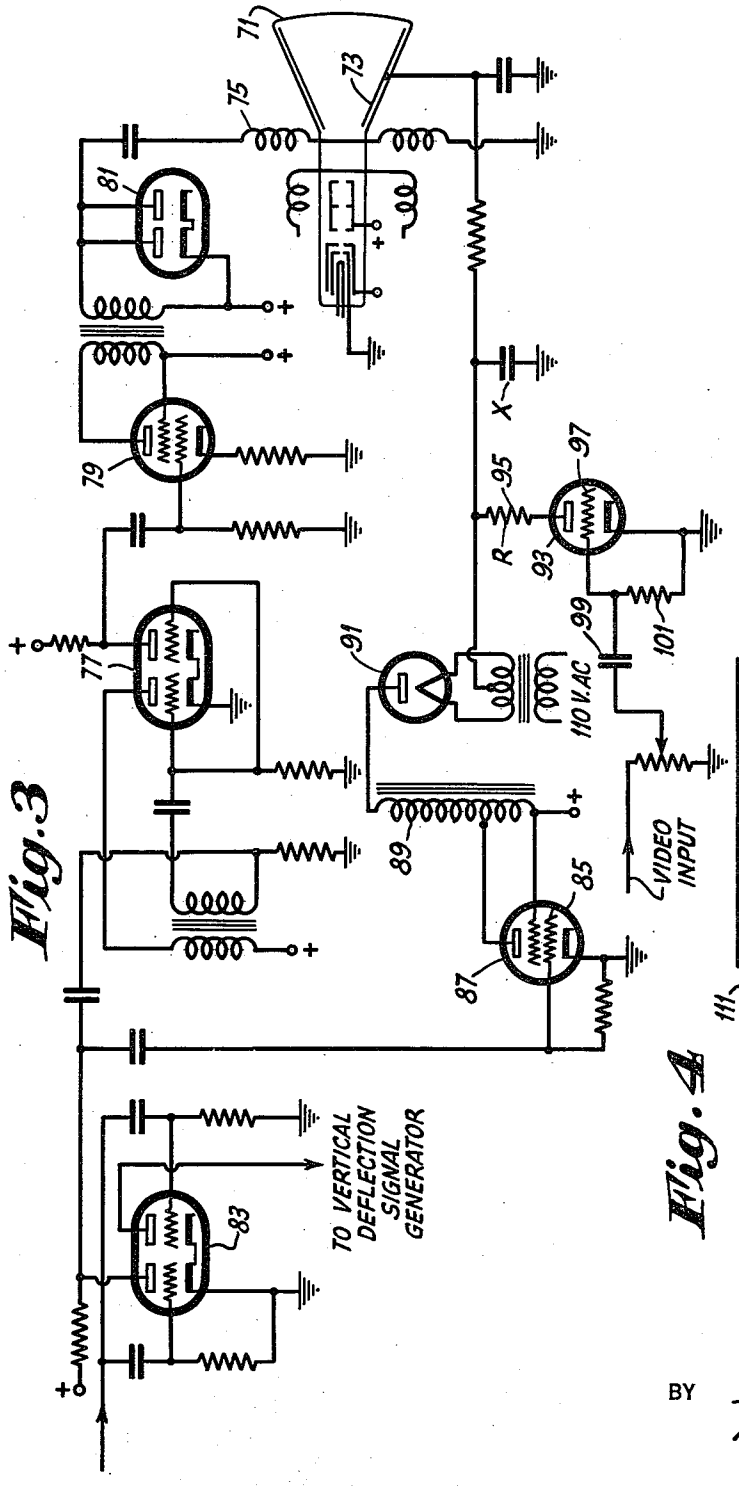


Fig. 3

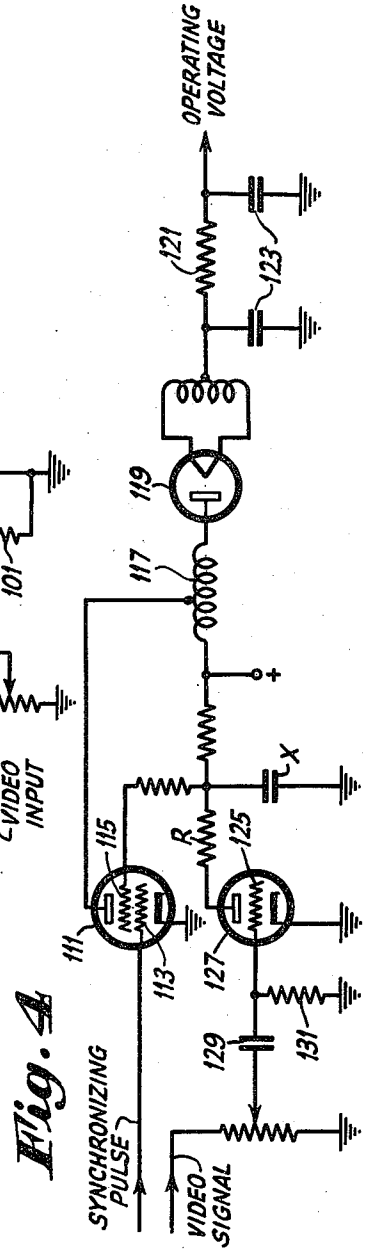


Fig. 4

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TELEVISION SYSTEM

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9 Claims. (Cl. 315—31)

1

This invention relates to power supplies for television systems and more particularly to regulation of the operating voltage for kinescopes and the like.

In the reproduction of images in television systems, it is usually customary to generate and deflect an electron beam in a cathode ray tube in a predetermined scanning pattern across a luminescent target to trace a scanning raster. The electron beam is normally generated by an electron gun which includes a cathode, usually indirectly heated, oxide-coated, and having a unipotential surface. The cathode serves as a source of electrons. A control electrode is placed adjacent to the cathode to regulate the number of electrons drawn out, and thereby permits the modulation of the intensity of the electron beam. A cathode region or first cross-over forming lens including the first anode and control grid concentrates the electron beam into a small diameter at a first cross-over. The electrons emerging from this first cross-over are collected and refocused to a small spot on the tube fluorescent screen by another focusing lens which includes the second anode and the first anode. The focal length of an electron lens is governed by the relative potential applied to its electrodes.

It follows that the focusing of the electron beam depends to a large extent upon the potential applied to the second anode. If the operating potential applied to the second anode is not properly regulated and tends to vary, not only with the variations of the source of potential, but with the load placed upon it, a defocusing of the electron beam will result.

There is, however, another form of image distortion resulting from a variation of the operating potential which becomes particularly objectionable in the reproduction of images in their natural color.

The amount an electron beam is deflected with a given deflection voltage is dependent upon the velocity of the electrons in the electron beam. The velocity of the electrons in the electron beam is dependent upon the operating voltage. It therefore follows that the amount an electron beam is deflected with a given deflection voltage will vary with any change in operating voltage.

In the reproduction of images in their natural color, it is common practice to provide a sequential scanning operation wherein each of the principal component colors of the subject are transmitted sequentially. It will be seen that

2

any change in image size resulting because of deviation from the proper deflection of the electron beam will cause serious distortion in the reproduction of images in their natural color by reason of the fact that the combination of the principal color images will not properly coincide.

Furthermore, sequential scanning of the same image element will not register at the same point on the screen if there is a change in operating potential.

The power supply that operates the electron gun in the cathode ray tube consists of two sources—the first source is generally alternating current voltage to heat the thermionic emitter or cathode from which the electrons to form the electron beam are obtained. This voltage is normally supplied by a transformer connected to the commercial power supply source. The other source, however, is a direct current voltage that applies the necessary potential difference between the cathode and control electrode, the screen grid, the first anode, and the second anode. It is customary to have a single source of direct current voltage which may be used for all these electrodes, and the different voltage levels required may be obtained from a voltage divider.

The high voltage or operating voltage required for the second anode may be obtained directly from the commercial source through a transformer, rectifier and filter circuit. It may be obtained by providing an auxiliary oscillator with appropriate rectifier, or it may be provided by deriving from the synchronizing pulse or deflection voltage a direct current voltage by rectification and filter action. By whatever means the operating voltage is obtained, it is important, however, that the regulation be such that the operating voltage will remain constant.

The second anode current changes with changes in picture brightness. The variations of the operating voltage resulting from poor regulation of the power supply will result in defocusing of the electron beam and misregistration in a sequential color system, as outlined above.

It has been proposed to provide a voltage regulation system for kinescope tubes wherein the voltage applied to the second anode is maintained substantially constant by direct regulation of the voltage applied to the second anode. Such a system operates quite satisfactorily, however, it has been discovered that the principal cause for a variation in the power consumed by

the second anode has been the changing image brightness. Other changes in operating voltage resulting from changes in source voltage are compensated for by reason of similar changes being applied to other elements of the circuit. It is therefore desirable that the regulation of the operating voltage applied to the second anode be controlled in accordance with the changing image brightness.

According to this invention, the operating voltage applied to the second anode of an electron gun of a cathode ray tube is controlled in accordance with the changing image brightness or the direct current and low frequency components of the video signal.

A primary object of this invention is to provide an improved television receiving system.

Another object of this invention is to improve image detail in kinescope tubes and the like.

Still another object of this invention is to provide improved regulation of high voltage power supplies for kinescope tubes and the like.

A further object of this invention is to overcome the defocusing of the scanning spot of a kinescope with changing image brightness.

A still further object of this invention is to overcome image distortion resulting from lack of registration of sequential scanning patterns in the reproduction of natural color images.

Other and incidental objects of the invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawing in which

Figure 1 shows a circuit diagram of one preferred form of this invention, employing an auxiliary oscillator for producing a regulated operating voltage for a kinescope or the like;

Figure 2 shows by circuit diagram another preferred form of this invention as applied to an operating potential power source, wherein the operating voltage is derived from a deflection voltage;

Figure 3 shows by circuit diagram still another preferred form of this invention wherein the operating voltage is derived from the synchronizing pulses; and

Figure 4 shows another form of this invention, as applied to the regulation of an operating voltage wherein the operating voltage is derived from the synchronizing pulses.

Turning now in more detail to Figure 1, there is shown a radio-frequency operated high-voltage supply of the type shown and described by O. H. Schade in an article entitled "Radio Frequency Operated High-Voltage Supplies for Cathode-Ray Tubes," beginning on page 158 of the "Proceedings of the Institute of Radio Engineers" for April 1943. The radio-frequency operated high-voltage supply may be employed to furnish the operating voltage for cathode ray tubes.

An oscillator tube 1 contains a control electrode 3 and an auxiliary control electrode 5. The oscillator circuit includes a primary coil 7 and a coil 9 to provide the necessary feed-back to cause tube 1 to oscillate.

Coil 9 has associated therewith a coil 11 which, in effect, steps up the voltage generated in coil 7 and applies it to a rectifier tube 13. An auxiliary coil 15, also coupled to coil 7, supplies the filament voltage for rectifier tube 13. A second rectifier tube 17 is connected to coil 11. Rectifier tube 17 is connected to a focusing control 19 which adjusts the relative value of the output voltages E_1 and E_2. An appropriate resistance condenser combination in resistance 21 and condensers 23 provides filter action for output potential E_2, and resistance 25 and condensers 27 provide appropriate filter action for output potential E_1.

Regulation control of the output potentials E_1 and E_2 is obtained by applying a video signal containing the D. C. and low frequency components to the auxiliary control electrode 5 of the oscillator tube 1. This is accomplished by applying a video signal in which blanking and synchronizing is in a positive direction to the control electrode 29 of tube 31. The peaks of the synchronizing pulses cause the tube to draw grid current charging the condenser 33 to a value corresponding to the D. C. component of the image. The theory and operation of D. C. reinsertion is explained in more detail beginning on page 367 of the book entitled "Principles of Television Engineering," by Donald G. Fink, and published in 1940.

The resistance capacity combination including condenser X and resistance R has a time constant so chosen in relation to the output filter circuit including resistor 21 and condenser 23 and also resistor 25 and condensers 27 to provide a smooth transition in regulation control from the filter condensers on the power supply output circuit to the control obtained from the D. C. component and very low frequency video components.

For the purpose of explanation, the terms "condenser X" and "resistor R" will be used in other figures where their function is analogous to that of condenser X and resistor R of Figure 1.

In Figure 2, there is shown a kinescope 41 which contains a second anode 43 and deflecting coils 45.

In view of the fact that a normal scanning pattern or raster is produced by a sawtooth wave, the sudden collapse of current in the deflecting coils 45 at the time of the return trace provides an extremely high voltage which can be rectified in rectifier 47 and applied as an operating voltage to second anode 43, after being submitted to appropriate filter action by the combination of resistor 48 and condensers 49 and 51.

The electron discharge device 53 and induction coil 55 are part of a deflection generator which may take any of the well known forms and may, for example, be similar to that shown and described in the U. S. Patent to W. A. Tolson et al., No. 2,101,520, December 7, 1937.

A control of the operating voltage applied to the second anode 43 is accomplished by providing an electron discharge device 57 connected in series with a resistor 59, which is in turn connected across the operating voltage applied to second anode 43. The impedance of electron discharge device 57 is controlled in accordance with the D. C. and low frequency components of the video signal by applying the video signal to control electrode 61 through an integrating circuit including capacity 63 and resistor 65, as shown, for instance, by P. W. Williams in U. S. Patent No. 2,252,746, granted August 19, 1941.

The phasing of the circuit is adjusted such that the impedance of electron discharge device 57 increases upon an increase in brightness of the image. It will be seen that such action will compensate for an increased current flow at anode 43 caused by increased image brightness.

A portion of the video input signal is applied to amplifier tube 66. The output of amplifier

signal 66 is applied to control electrode 67 of kinescope 41.

As is well-known to the art the video signal applied to the control electrode of the image reproducing tube must include the direct current component in order to faithfully reproduce the image. The D. C. reinsertion, as it is sometimes called, is accomplished in diode 68 which acts in accordance with D. C. reinsertion theory to properly establish the direct current level during each blanking pulse.

It is not the intention here to relate the theory of D. C. reinsertion, but this arrangement is included, by way of example, in order to illustrate how the video signal input may be applied to the control electrode of a circuit arrangement, as illustrated in Fig. 2.

A detailed description of such a D. C. reinsertion may be found on page 367 of the book entitled "Principles of Television Engineering" by Donald G. Fink, first edition, 1940.

Turning now to Figure 3, there is shown still another form of this invention, wherein the operating voltage is derived from the synchronizing pulses. Kinescope 71 contains a second anode 73 and deflecting coils 75. The deflection voltage for coil 75 is obtained from sawtooth wave generator 77. The sawtooth wave voltage is amplified in electron discharge device 79. Rectifier 81 is provided for damping the sawtooth wave deflection voltage in the conventional manner.

Electron discharge device 83 operates as a horizontal and vertical synchronizing signal separator. Because of the higher frequency of the horizontal synchronizing signal, it is preferred that the horizontal synchronizing signal be employed to provide a source for the desired operating voltage.

The operation of electron discharge devices 77, 79, 81, and 83 is conventional and may, for example, take the form of the circuit shown and described beginning on page 470 in the book entitled "Principles of Television Engineering" by Donald G. Fink, published by McGraw-Hill Book Co., Inc., in 1940 and referred to above.

The operating voltage is derived by applying the synchronizing pulse signal to control electrode 85 of tube 87. The output circuit of tube 87 includes an auto-transformer 89 for deriving from the amplified synchronizing pulse an extremely high peak voltage, which is in turn rectified in rectifier 91, and after appropriate filtering, is applied to the second anode 73 of kinescope 71.

A control of the operating voltage is provided in a manner similar to that shown in Figure 2 by connecting a tube 93 in series with a resistor 95. The tube 93 and resistor 95 are connected to provide a variable impedance across the source of operating voltage. The impedance of tube 93 is governed by applying a video signal to control electrode 97 of tube 93 through an integrating circuit including capacity 99 and resistor 101.

There is shown in Figure 4 another form of control circuit in accordance with one form of this invention, wherein the amplifying tube 111 contains a control electrode 113 to which is applied the incoming synchronizing pulses. Tube 111 also contains an auxiliary electrode 115 which effectively controls the amplification factor of tube 111. The output circuit of tube 111 is connected to an auto-transformer 117, which produces an extremely high voltage in a manner similar to that produced by auto-transformer 89 of the circuit shown in Figure 3.

Rectifier 119 produces a direct current voltage which, after passing through the filter circuit including resistor 121 and condensers 123, provides the necessary operating voltage.

The control of the operating voltage is accomplished by applying a video signal to the control electrode 125 of tube 127. The video signal is passed through an integrating circuit containing condenser 129 and resistor 131. The anode 133 of tube 127 is connected to the auxiliary control electrode 115 of tube 111 in such a manner that the amplification factor of tube 111 will increase upon the application of an increased video signal. It therefore follows that the operating voltage produced will be controlled by the video signal voltage, and therefore the operating voltage will, in effect, be controlled in accordance with the video signal or changing image brightness.

Although not shown by circuit diagram, this invention in another of its preferred forms may be applied to the conventional high voltage supply consisting of an iron core step-up transformer energized from the 60-cycle power line, and employing a rectifier circuit with appropriate smoothing filter. In such a form of power supply, regulation in accordance with this invention may be provided by the use of a tube whose impedance is connected in the operating voltage circuit and whose impedance is controlled in accordance with the video signal.

Having thus described my invention, what is claimed is:

1. In a cathode ray tube apparatus, a cathode ray tube having a control electrode adapted to receive an image detail signal voltage and an electrode adapted to receive an operating voltage, means for integrating said signal voltage, and means for controlling said operating voltage with said integrated signal voltage.

2. In a cathode ray tube apparatus, a cathode ray tube having deflecting coils, a ray intensity control electrode adapted to receive a control voltage, means for developing a control voltage and an electrode adapted to receive an operating voltage, means for producing an operating voltage, and means for controlling said operating voltage in accordance with the average amplitude of said control voltage.

3. In a television system of the type employing an image tube requiring an operating voltage for the reproduction of images from video signals, a control circuit for said operating voltage comprising in combination a source for said operating voltage, a signal integrating circuit adapted to receive said video signals, an electron discharge device having an input and output circuit, said input circuit connected to said integrating circuit, and a connection between said source of operating voltage and said output circuit of said electron discharge device to effectively control said operating voltage.

4. In a television system of the type employing an image tube requiring an operating voltage for the reproduction of images from video signals, a control circuit for said operating voltage comprising in combination a source of alternating current voltage, a rectifier for said alternating current voltage, a filter circuit connected to said rectifier, a signal filter circuit adapted to receive said video signals, an electron discharge device having a control electrode and an anode, said control electrode connected

to said signal filter circuit, and a connection between said source of alternating current voltage and said anode of said electron discharge device to control said operating voltage.

5. In a television system of the type employing an image tube requiring an operating voltage for the reproduction of images from video signals, a control circuit for said operating voltage comprising in combination a filter circuit adapted to receive said video signals, an electron discharge device having an input and output circuit, said output circuit connected in parallel with said operating voltage, said input circuit connected to said filter circuit.

6. In a television system of the type employing an image tube requiring an operating voltage for the reproduction of images from video signals, a control circuit for said operating voltage comprising in combination a beam deflection signal generator for said image tube, a rectifier connected to said beam deflection signal generator to derive therefrom said operating voltage, a signal integrating circuit adapted to receive said video signals, an electron discharge device having an input and output circuit, said input circuit connected to said integrating circuit, and a connection between said rectifier and said output circuit of said electron discharge device to control said operating voltage.

7. In a television system of the type employing an image tube requiring an operating voltage for the reproduction of images from video signals, a control circuit for said operating voltage comprising in combination a source of beam deflection signals for said image tube, a circuit connected to said source of beam deflection signals to derive therefrom said operating voltage, a signal integrating circuit adapted to receive said video signals, an electron discharge device having an input and output circuit, said input circuit connected to said integrating circuit, and a connection between said circuit connected to said source of beam deflection signals and said output circuit of said electron discharge device to control said operating voltage.

8. In a cathode ray tube apparatus for employment in the reproduction of images by a series of

scanning lines, a cathode ray tube having a control electrode adapted to receive a control voltage and an electrode adapted to receive an operating voltage, a control circuit for said operating voltage comprising in combination a signal filter circuit having resistance and capacity included in a circuit arrangement whose resistance capacity time constant is at least as great as the time interval occupied by one of said scanning lines adapted to receive said control voltage, an electron discharge device having an input and output circuit, said input circuit connected to said integrating circuit, and a connection between said source of operating voltage and said output circuit of said electron discharge device to control said operating voltage.

9. In a cathode ray tube apparatus, a cathode ray tube having a control electrode adapted to receive a control voltage and an electrode adapted to receive an operating voltage, a control circuit for said operating voltage comprising in combination a signal integrating circuit adapted to receive said control voltage, an electron discharge device having an input and output circuit, said input circuit connected to said integrating circuit, an oscillation generator including a second electron discharge device having a control electrode, a rectifier connected to said oscillation generator, a filter circuit connected to said rectifier to provide said operating voltage, and a connection between said filter circuit and said control electrode of said second electron discharge device to control said operating voltage.

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