Jan. 6, 1959 W. E. GLENN 2,867,687

CATHODE RAY REPRODUCTION TUBE HAVING AUXILIARY FUNCTION OF SYNCHRONIZING SIGNAL SEPARATION

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Fig. 1.

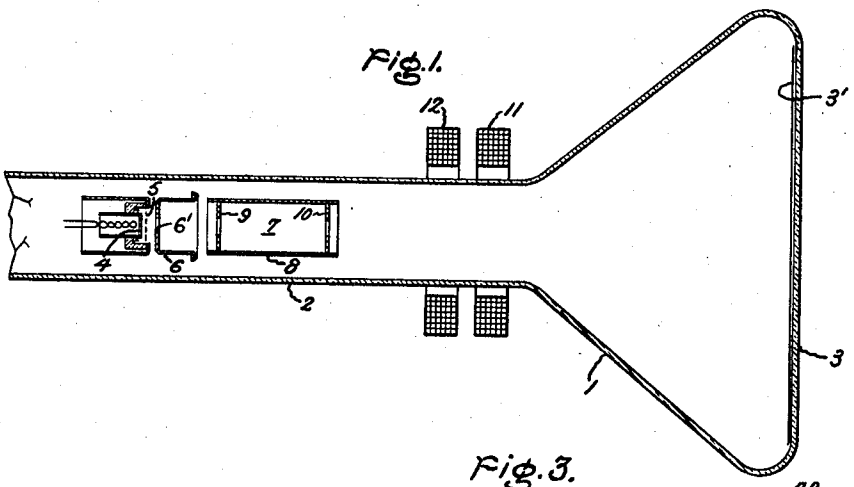


Fig. 3.

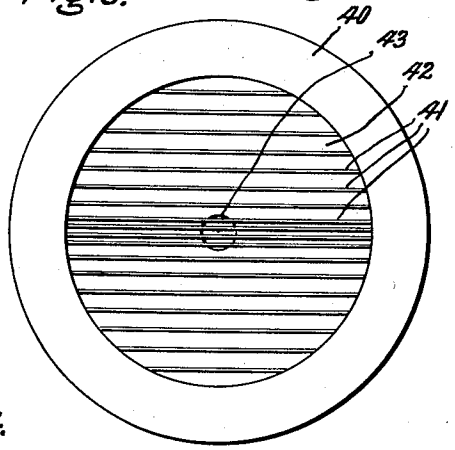


Fig. 2.

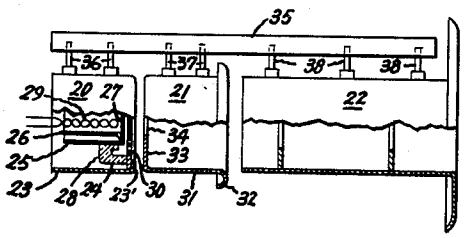
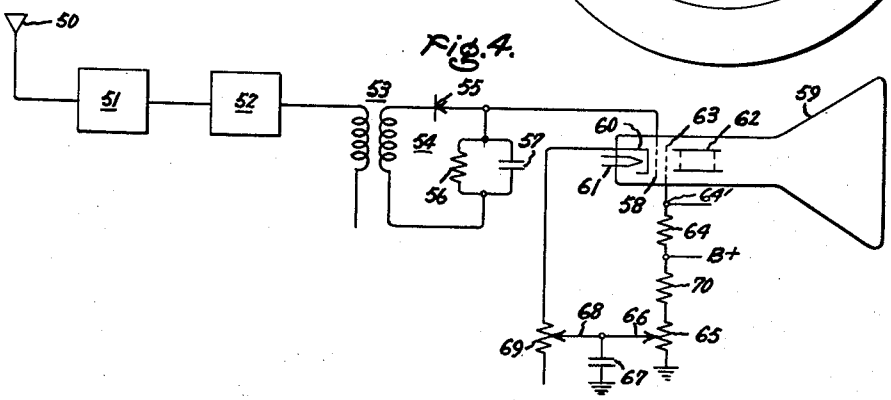


Fig. 4.



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CATHODE RAY REPRODUCTION TUBE HAVING AUXILIARY FUNCTION OF SYNCHRONIZING SIGNAL SEPARATION

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4 Claims. (Cl. 178—7.5)

My invention generally relates to cathode ray discharge devices and, more particularly, to such devices as may be utilized to display a visual image on the face thereof and simultaneously to act as an amplifier.

In many applications of cathode ray discharge devices the intensity control signal may be used for purposes in addition to the controlling of the intensity of the electron beam. For example, in present-day television receivers, the amplitude modulated high-frequency signal received thereby comprises both picture information and synchronizing information. In standard receivers, as known in the prior art, a demodulator is supplied with the received signal, and a portion of the output of the demodulator is amplified and supplied to the control grid of the picture tube. Another portion of the output of the amplifier is supplied to the sweep voltage generator synchronizing circuits. It is advantageous, therefore, to provide a single device suitable for the utilization of both of these signals.

An object of my invention is, therefore, to provide a new and improved electron gun structure for a cathode ray discharge device.

Another object of my invention is to provide a new and improved cathode ray discharge device wherein the cut-off potential of the electron beam is of the order of a few volts.

A further object of my invention is to provide a new and improved cathode ray discharge device wherein a signal supplied to a control electrode thereof influences the intensity of the cathode ray beam and also effects an amplified signal on an electrode of the discharge device.

A still further object of my invention is to provide a new and improved synchronizing pulse amplification circuit for use in a television receiver.

In the attainment of the foregoing objects I provide an electron gun structure having closely spaced grid wires and an interelectrode distance between the cathode and the control grid thereof which is substantially less than heretofore employed in cathode ray discharge devices. Furthermore, I provide in close proximity to the control electrode an accelerating anode having a relatively small aperture therein such that only a portion of the electrons emitted from the cathode pass therethrough. Furthermore, in accordance with another aspect of my invention the grid is arranged such that the perforate area is minimized in that area opposite the aperture in the anode. Because of this unusual arrangement, the device may be operated as an amplifier for voltage signals supplied to the control grid as well as for displaying an image corresponding to a portion of the applied signal.

For further objects and advantages and for a better understanding of my invention, attention is now directed to the following description and accompanying drawings, and also to the appended claims wherein those features of novelty which characterize my invention are pointed out with particularity. In the drawings:

Figure 1 is a longitudinal sectional view of a cathode ray discharge device embodying certain aspects of my invention;

Figure 2 is a partial, longitudinal cut-away view of an electron gun employing the novel features of my invention;

Figure 3 is an end view of a portion of the electron gun of Figure 2;

Figure 4 is a schematic electric circuit diagram of a portion of a television receiver embodying my invention.

In Figure 1 there is schematically illustrated a cathode ray discharge device having a body portion 1 and a neck portion 2. A face 3 on the inner surface of which is provided a phosphor layer 3' constitutes one wall of the body portion, and the remainder of the body is defined by a hollow cone having the apex thereof attached to neck 2. The overall enclosure is evacuated and hermetically sealed.

An electron gun generally comprising a cathode 4, a foraminated electrode 5, an anode 6 and a conventional focusing electrode 7 is disposed within neck 2. Anode 6 is provided with a centrally located aperture 6'. Focusing electrode 7 includes a hollow cylindrical body portion 8 having inwardly extending annular members 9 and 10.

A positive potential is supplied to anode 6 to effect a high field intensity at the surface of cathode 4 whereby electrons emitted therefrom are impelled toward anode 6. While a large number of these electrons strike anode 6, a number of them pass through aperture 6' and are focused into a beam by the focusing electrode 7. In the particular cathode ray discharge device which is illustrated, magnetic focusing and deflection of the beam is provided to effect an image on face 3 thereof. A toroidal sweep coil 11 is suitably provided about the neck of the tube, and a focusing coil 12, also a toroidal coil, is provided about the neck of the tube. Since the operation of such focusing and sweep magnetic fields in television receiver systems are well known in the art, for purposes of clarity, their operation will not be described herein.

In operating this device as a television receiver picture tube, the detected video signal may conveniently be supplied to control electrode 5 to regulate the quantity of electrons passing through aperture 6' in the accelerating anode. Consequently, the image appearing on the face of the tube is controlled in conjunction with the magnetic fields provided by coils 11 and 12 in the usual manner.

I have found, however, that by positioning the control electrode in very close proximity to the cathode and adding closely spaced grid wires, the tube may be directly operated by a television detector output signal. Since the voltage of the black level appearing at the output of the detector is usually about two volts, it is necessary that cut-off of the electron beam occur at this value. In one embodiment I have accomplished this by positioning the control electrode .6 mil away from the cathode with .3 mil grid wires spaced 1 mil center to center.

Furthermore, by positioning the accelerating anode in close proximity to the control electrode and by providing a very narrow aperture therein, the transconductance of that portion of the device comprising the cathode, control electrode and accelerating anode is sufficiently high that it may be operated as a triode amplifier. While other dimensions may be utilized, an embodiment of this invention utilizes an aperture of 10 mils diameter in an anode of 125 mils diameter. The complete electron gun structure has a transconductance of the order of 10,000 while at the same time providing an electron spot on the face of the tube which is smaller than is necessary to meet the normal television system requirements. The diameter of the aperture in the accelerating anode is of such size as to pass a sufficient number of electrons emitted from the cathode to meet standard television requirements regarding intensity of the beam, and by providing such a very small aperture, the number of electrons impinging on anode 6 are sufficient to meet normal amplifier requirements. Consequently, a device having

a transconductance of sufficient magnitude for operation as an amplifier is effected.

Figure 2 illustrates an electron gun embodying one aspect of my invention whereby a control grid is mounted in very close proximity to a cathode. In this gun, there is generally provided a cathode-grid portion 20, an accelerating anode portion 21, and a focusing electrode portion 22. The cathode-grid portion comprises a metallic cylindrical member 23 in the central cavity of which is located the cathode structure. The supporting structure for the active cathode surface 24 is of hollow cylindrical configuration and consists of a thin walled tubular member 25, preferably constructed of metal foil, a metallic sleeve or eyelet 26, and a metallic disk 27. Eyelet 26 is fastened to the underside of disk 27, as, for example, by welding, and disk 27 is fastened about the periphery thereof to one end of tubular member 25.

A cylindrical insulating member 28 constructed of a good insulating material such, for example, as ceramic, is provided with a triangularly-shaped central aperture, and cylinder 25, which is of a diameter to make contact at three points of this triangle, is interposed within this aperture. The inner walls of insulating cylinder 28 are metalized and cylinder 25 is brazed thereto.

Within the cathode structure, and, more specifically, within the depending sleeve or eyelet 26, there is provided a filamentary heater 29 which suitably consists of a double helix of tungsten or any other of the well known metals or alloys applicable for use as heating filaments in electron discharge devices. A control electrode 30 in the form of an annular member having parallel wires extending across the central opening thereof is mounted on one end of insulating cylinder 28 and may conveniently be welded thereto. In this embodiment, it is necessary that the metallic coating not cover the entire surface of the ceramic cylinder 28 or the function of the cylinder as an insulator between the cathode and the grid will be nullified. Consequently, only the inner wall thereof and the upper end thereof are provided with the metallic coating. The brazing solder utilized to braze the grid and the cathode to the ceramic is preferably a metal or alloy which melts in the range of 1000° C. so as to enable tube processing without a loss of rigidity of the cathode grid assembly. The face of electrode 30 which is opposite that portion brazed to the insulating cylinder 28 may conveniently be brazed to the inwardly extending flange 23' which is provided at one end of cylinder 23. This structure provides accurate cathode to grid spacing, and, in addition, provides a simple method for maintaining the cathode to grid distance constant during operation of the device. It will be seen that a single member, that is, insulating cylinder 28, determines the spacing between the cathode and the grid.

In the manufacture of this structure, the upper surface of insulating cylinder 28 is ground optically flat and is thereafter used as the reference plane. The subassembly of disk 27 bonded to cylinder 25 is then mounted and brazed within member 28. The active electron emissive surface is then applied to the surface of disk 27, and using the accurately ground plane on insulator 28 as a reference, the surface of the cathode is ground flat and parallel with this reference plane. Consequently, when the grid is juxtaposed with the reference plane upon insulator 28, it is both parallel and accurately fixed in its relationship with the cathode. Furthermore, since the cathode structure is supported from points in close proximity with the active emissive surface, the problem of parallelism between the grid and cathode is less acute than in the presently known types of tube constructions.

Accelerating anode 21 comprises a metallic cylindrical member 31 having an outwardly extending annular flange 32 at the end thereof toward the face of the tube and an inwardly extending annular flange 33 at the end thereof adjacent the cathode-grid structure. A centrally located aperture 34 is provided opposite control electrode 30.

Since the focusing electrode 22 is of the type well known in the art, for purposes of clarity, it will not be described herein.

The three major parts of the electron gun are fixedly mounted with respect to one another for disposition within the neck of a cathode ray discharge device upon a plurality of insulating rods. These rods extend along the outside of the cylindrical body portions of the gun parallel to the longitudinal axis thereof. In the embodiment shown in Figure 2, three glass rods 35 are so positioned at one hundred twenty degree intervals about the periphery of the gun. A plurality of rods 36, 37 and 38, conveniently but not necessarily constructed of metal, extend radially from each of the major parts of the gun and are imbedded within glass rods 35. A good mechanical structure is thereby provided for accurately holding the cathode-grid assembly, the anode assembly, and the focusing electrode assembly in alignment. Since the relationship between the cathode and the control grid is the most critical, the highly accurate alignment and spacing structure is employed. The anode to grid spacing need not be as precise and the less accurate supporting structure may be satisfactorily employed.

In utilizing a cathode ray discharge device as a device for the production of visual images and also for the amplification of the control signal, it has been found desirable that the amplifier portion be suitable for use with input voltages exceeding the cutoff potential of the discharge device. For example, in a television system, it is desirable that the device be used to amplify the synchronizing pulses appearing at the output of the detector. Since the synchronizing pulses extend beyond the black level of the input signal, and since it is desirable that cutoff of the electron beam be effected in the immediate vicinity of the black level, it is necessary that the triode amplifier amplify signals well beyond the black level; whereas, the electron beam should be cut off at the black level.

In Figure 3, there is illustrated an end view of the grid and accelerating anode structures of a preferred embodiment of this invention which has this desirable characteristic. The grid comprises an annular member 40 having provided across the central aperture thereof a plurality of parallel wires 41. The anode 42 is provided with a centrally disposed aperture 43. The grid wires are unequally spaced such that the wires are more closely spaced opposite aperture 43 in anode 42. With this arrangement, the cutoff voltage of the device, that is, that voltage required to completely cut off the passage of the electron beam through the grid, is a minimum in the vicinity of the aperture in the anode. Therefore, while a relatively low voltage may be employed to cut off the electron beam appearing at the face of the tube, higher voltages may be amplified in the remaining portion of the grid and anode structures. Figure 3 is for purposes of illustration only, and the relative dimensions thereof are not those as would usually be provided in a practical application. For example, in one television receiving tube, constructed in accordance with the teachings of this invention, the diameter of the aperture in annular member 40 is of the order of one eighth inch, and the diameter of the aperture in the first accelerating anode is of the order of ten mils.

Because the ratio of the diameter of the active anode surface to the diameter of the aperture therein is approximately twelve to one, only a small percentage of the electrons normally impinging on the anode are cut off when the electron beam is interrupted by a black level voltage signal from a conventional detector of a television receiver. It can be readily computed that the effect of such a cut-off voltage is to reduce the area of the anode by eight percent. The effect of this reduction in anode surface on the transconductance is so small as not to appreciably interfere with the operation of the device as a triode amplifier. It will be understood, however,

that this factor should be considered when designing circuits for use in conjunction with a cathode ray tube employing such a variable cut-off control electrode.

In Figure 4 wherein is illustrated a portion of a television receiver embodying the principles of my invention, a receiving antenna **50** is coupled to the RF circuits **51** wherein the amplitude modulated picture and synchronizing signals are heterodyned and supplied to the intermediate frequency video channel **52**. The output of the video circuits **52** is coupled through a transformer **53** to the detector circuit **54**. Detector circuit **54** is a conventional amplitude detector and comprises a unidirectional impedance device **55** serially connected with a parallel circuit arrangement of a resistor **56** and a capacitor **57** across the secondary winding of transformer **53**. The output of this video detector is coupled to the control grid **58** of a television picture tube **59**. Tube **59** also includes an indirectly heated cathode **60** and associated filament **61**, an electrostatic focusing electrode structure **62**, and an accelerating anode **63** of the type hereinbefore described. Anode **63** is connected through a resistor **64** to a source of positive voltage B+. Potentiometer **65** is connected by resistor **70** to the source of positive voltage B+. The variable tap **66** on potentiometer **65** is connected through a capacitor **67** to ground and is also connected to a variable tap **68** on a resistor **69**. As will be apparent to those skilled in the art, variable resistor **69** is the contrast control, and potentiometer **65** is the brightness control for the television picture tube.

Since the black level video output voltage of a conventional television detector circuit is of the order of 2 volts, no amplification of this signal is required before it is coupled to the control electrode of the discharge device to control the intensity of the electron beam. Since, however, as hereinbefore described the synchronizing pulses exceed the black level at which the image reproduction portion of the tube is cut off, the signal appearing at anode **63** includes the synchronizing pulses even though the electron beam is cut off. These amplified synchronizing pulses may conveniently be taken from terminal **64'** and coupled to the synchronizing circuit where they may be separated from the varying video signal. Therefore, cathode ray discharge device **59** functions as a picture display means as well as a triode amplifier for amplification of the synchronizing signals which are detected in a normal detector circuit.

While I have described my invention in conjunction with a standard black and white television system, it will be understood that my invention is not limited thereto. For example, my device may be operated as a cathode follower in a negative feedback loop of a color television system to provide the good linearity there required. In such an embodiment uniform spacing of the grid wires is provided. Therefore, by the appended claims, I intend to cover all such changes and modifications which fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a television receiver for the utilization of picture and sweep synchronizing signals the combination of a demodulator connected to be supplied with a high frequency wave including both picture and synchronization information with a cathode ray discharge device for displaying the picture having a cathode, a control grid, an accelerating anode and screen supported in spaced relation in the order named, said control grid and said accelerating anode having aligned apertures therein interposed in the path between said cathode and said screen with the aperture in said accelerating anode of substantially larger area than the aperture in said control grid and conducting means extending across the aperture of said control grid and providing the outer portion of the aperture therein with a more negative cutoff characteristic than the central portion thereof so that as the control electrode voltage becomes more negative the cutoff point for the beam current to said screen is reached before the cutoff point for electrons collected by said anode, means connecting the output of said demodulator circuit to said control grid and means connecting said anode to an output circuit for utilizing synchronizing information from said demodulator produced by electrons collected on said accelerating anode.

2. In a cathode ray discharge device, an accelerating anode electrode having an aperture surrounded by an electron collecting surface, a control grid electrode having an aperture therein of substantially larger area than the aperture in said anode electrode, means including a cathode electrode providing an electron beam of larger cross sectional area than the aperture in said accelerating anode electrode, said electrodes being supported in mutually spaced and insulated relation in the order named, conducting means extending across the aperture in said control grid for determining the cutoff characteristic thereof, said conducting means providing smaller openings in the area of the aperture in said control grid electrode opposite the aperture in said accelerating anode electrode to provide a less negative cutoff voltage point for the portion of said grid opposite the aperture in said accelerating anode than the cutoff voltage point for the portion of the aperture in said control grid opposite said electron collecting surface so that said control grid may be energized to pass electrons from said emitting surface to said collecting surface while preventing the flow of electrons from said emitting surface through the aperture in said accelerating anode.

3. In a cathode ray discharge device, an accelerating anode electrode having an aperture and an electron collecting surface laterally displaced from the aperture, a control grid electrode having an aperture therein of substantially larger area than the aperture in said anode electrode, means including a cathode electrode providing an electron beam of larger cross sectional area than the aperture in said accelerating anode electrode, said anode electrode, said control grid electrode and said cathode electrode being supported in mutually insulated and spaced relation in the order named, a screen positioned on the side of said accelerating anode remote from said cathode for receiving electrons through the aperture of said accelerating anode under the control of said control grid electrode, and spaced conducting means extending across the aperture in said control grid electrode for determining the cutoff characteristics thereof, said conducting means having smaller minimum spacing in the area of the aperture in said control grid electrode opposite the aperture in the accelerating anode electrode to provide a more negative cutoff voltage characteristic for the portion of said control grid electrode opposite the aperture in said accelerating anode electrode than the cutoff voltage characteristic for the portion of the aperture in said control grid electrode opposite said electron collecting surface so that said control grid electrode may be energized to pass electrons from said cathode electrode to said collecting surface while preventing the flow of electrons from said cathode electrode through the aperture in said accelerating anode electrode to said screen.

4. In a cathode ray discharge device, an accelerating anode electrode having an aperture and a laterally displaced electron collecting surface, a control grid electrode having an aperture therein of substantially larger area than the aperture in said anode, means including a cathode electrode providing an electron beam of larger cross sectional area than the aperture in said accelerating anode electrode, said anode electrode, said control grid electrode and said cathode electrode being supported in mutually insulated and spaced relation in the order named, and a screen positioned on the side of said accelerating anode electrode remote from said cathode for receiving electrons through the aperture of said accelerating anode under the control of said con-

trol electrode, said control grid electrode including conducting means extending across the aperture in said control grid electrode to provide the portion of said grid electrode opposite the aperture in said accelerating anode electrode with a less negative cutoff voltage than the cut-off voltage for the portion of the aperture in said control grid electrode opposite said electron collecting surface so that said control grid electrode may be energized to pass electrons from said cathode electrode to said collecting surface while preventing the flow of electrons from said

cathode electrode through the aperture in said accelerating anode to said screen.

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