Dec. 8, 1959 D. W. DAVIS 2,916,661

STORAGE CATHODE RAY TUBE

Filed Aug. 20, 1958

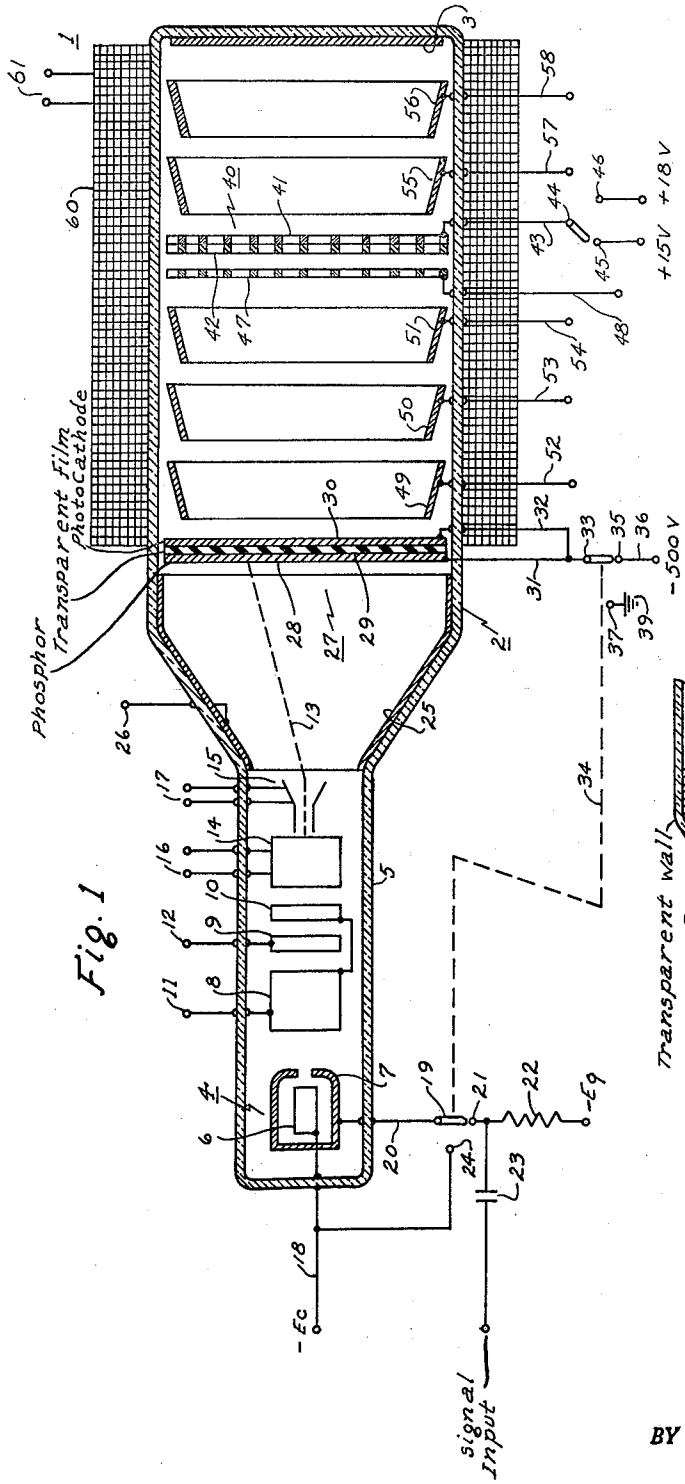


Fig. 1

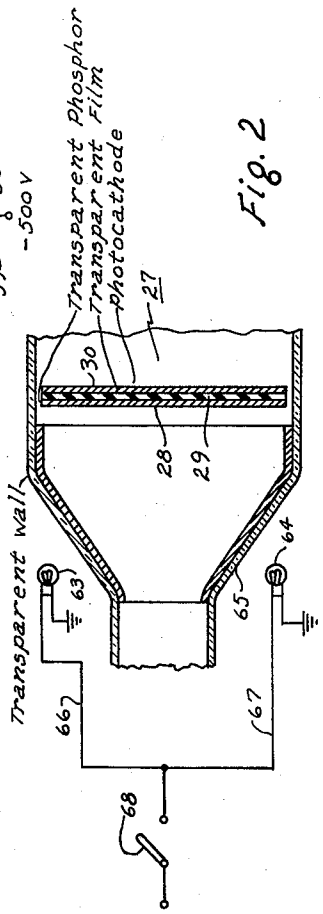


Fig. 2

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United States Patent Office 2,916,661 Patented Dec. 8, 1959

2,916,661

STORAGE CATHODE RAY TUBE

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Application August 20, 1958, Serial No. 756,155

8 Claims. (Cl. 315—11)

This invention relates generally to storage cathode ray tubes and more particularly to storage cathode ray tubes of the signal-to-image type in which an electrical input signal is "written" into the storage system of the tube and thereafter "read-out" as a visual display.

Conventional signal-to-image storage cathode ray tubes comprise an enclosing envelope with a phosphor display screen arranged at one end and with a conventional electron gun assembly arranged at the other end. A charge storage screen, commonly formed as a fine mesh metal screen with secondary emissive insulator material on one side thereof is disposed between the display screen and the electron gun with its insulator surface facing the electron gun. The electrical input signal is commonly connected to a control grid of the electron gun which is arranged to scan a high velocity electron beam over the insulator surface of the storage screen; impingement of the electron beam on the insulator surface of the charge storage screen results in secondary emission therefrom thus forming a charge pattern or image on the insulator surface corresponding to the electrical input signal. The charge image which has thus been "written" on the insulator surface of the storage screen is commonly "read-out" by subsequently flooding the charge storage screen with a uniform flood beam of low velocity electrons, these low velocity electrons passing through the openings in the charge storage screen, being modulated by the incremental charges on the insulator surface thereof, and impinge upon the phosphor display screen thereby forming a visual image corresponding to the charge image on the insulator surface of the storage screen; the low velocity flood beam of electrons is commonly provided by another conventional electron gun in the envelope.

In prior signal-to-image storage tubes known to the present applicant, the minimum spot size of the incremental elements of the visual display is limited to something greater than the size of the mesh openings in the storage screen because the mesh-formed low velocity electron beams spread after going through a cross-over close to the storage screen. It is possible to focus the low velocity electron beams between the storage screen and the phosphor display screen with a magnetic focusing field thereby to reduce the minimum spot size of the display image and to provide accompanying increase in the resolution thereof. However, to the best of the present applicant's knowledge, no practical method has been found to restrict the magnetic focusing field to the region between the storage screen and the phosphor display screen. In conventional signal-to-image tubes, the low velocity flood electron beam is emitted from a small area cathode and the effect of the magnetic focusing field which unavoidably enters the section of the tube containing the flood electron gun is to focus the low velocity electron beam from the cathode onto the storage screen instead of allowing the flood beam to spread so as to illuminate the entire area of the insulator surface of the storage screen as is required in tubes of this type.

Another problem in the design of signal-to-image storage cathode ray tubes is the relative locations of the high velocity "writing" beam electron gun, and the low velocity flood gun. It has commonly been found most desirable to mount the flood electron gun along the axis of the tube in order to avoid image shading in the visual display on the display screen. Paradoxically, however, the most desirable place for the high velocity writing electron gun is also along the axis of the tube in order to avoid distortion of the charge image on the insulator surface of the storage screen. It has, however, been the general practice to mount the writing gun so that it is off-set from the axis of the tube.

Conventional signal-to-image storage tubes provide a visual displayed image having high brightness and high contrast capabilities. However, in tubes of this type known to the present applicant, the resolution of the displayed image deteriorates with increased brightness since, as the flood beam current is increased, the spot size in the displayed image also increases. It has therefore long been felt desirable to provide a signal-to-image storage tube in which the high contrast capabilities of present tubes are retained and in which the low velocity electron beam forming the display image could be properly focused thereby to improve the resolution of the tube. It has further long been felt desirable to provide a signal-to-image storage tube construction in which the writing beam gun could be located on the axis of the tube thereby eliminating the distortion encountered with the writing gun off-set from the tube axis, but in which corresponding off-setting of the source of flood electrons was not necessary; while the use of ring-type flood guns concentrically surrounding the writing gun has been proposed, difficult problems in gun geometry are found in such constructions in order to insure uniform coverage of the charge storage screen with the flood beam.

The storage image converter tube is an image-to-image tube well known in the art. In such tubes, a large area photocathode is arranged at one end of the tube with a phosphor display screen being arranged at the other end and a storage screen being arranged intermediate the photocathode and the display screen. Thus, a radiation image impinged upon the photocathode excites the same to emit photoelectrons in a pattern corresponding to the incident radiation image, these photoelectrons again by secondary emission forming a charge image on the insulator surface of the storage screen. This charge image in the case of the storage image converter tube is conventionally "read-out" by uniformly illuminating the photocathode with a source of flood illumination thus exciting the photocathode to emit a uniform beam of low velocity electrons which, as in the case of the signal-to-image storage tube, pass through the storage screen, being modulated by the incremental charges thereon to provide a visual display on the display screen. In the storage image converter tube, the flooding photocathode is, itself, as large as the area it must flood on the insulator surface of the storage screen and thus, magnetic focusing of the flood beam may be provided since the magnetic field does not, in this case, reduce the diameter of the flooded area. In conventional signal-to-image storage tubes, high contrast and brightness are obtained at the expense of resolution, while in conventional storage image converter tubes, high resolution is obtained but brightness is necessarily lower because of the lower emission available from a photocathode compared to a thermionic cathode for flooding.

This invention, therefore, contemplates the use of a large area flooding photocathode in a signal-to-image storage cathode ray tube thus to permit magnetic focusing of the image section. My invention, therefore, in its broader aspects, provides a storage cathode ray tube having a phosphor display screen and a planar target electrode

spaced from the display screen and including a phosphor layer and a layer of photocathode material facing the display screen and arranged to be excited to emit photoelectrons by fluorescence of the phosphor layer. The writing electron gun is arranged to scan an electron beam over the phosphor layer of the target electrode thereby causing fluorescence of the same and in turn exciting the photocathode material layer to emit photoelectrons toward the display screen. A perforate charge storage screen is arranged intermediate the target electrode and the display screen. Means are provided for impressing an input signal on the electron gun and a suitable potential on the photocathode material layer so that scanning of the phosphor layer with the electron beam responsive to the input signal causes the photocathode material layer to emit electrons which are then accelerated to high velocity to produce the charge image on the storage screen by secondary emission. Means are further provided for exciting the photocathode material layer to emit a uniform flood beam of electrons which pass through the openings in the storage screen with low velocity, being modulated by the charge image thereon, thereby to form the visual image on the display screen. In accordance with my invention, magnetic focusing means is arranged to focus the photoelectrons from the photocathode material layer onto the charge storage screen, and to focus an electron image of the charge storage screen on to the display screen, the magnetic field provided by the magnetic focusing means having negligible deleterious effect on the electron beam from the electron gun scanning the phosphor layer since the magnetic field is weak in that region of the tube and the velocity of the gun electron beam is very high. In one embodiment of my invention, the scanned electron beam from the electron gun is used not only for writing the input signal upon the phosphor layer in turn exciting the photocathode to emit electrons accelerated at high velocity toward the storage screen, but is also used for scanning a uniform intensity beam over the phosphor layer with the potential impressed on the photocathode material layer being altered so that it emits a uniform beam of electrons accelerated with low velocity toward the storage screen for reading out the charge image stored thereon. In another embodiment of my invention, the low velocity flood photoelectrons from the photocathode material layer are provided by illuminating the phosphor layer with a flooding source of light positioned outside of the tube envelope. The magnetic focusing means in one embodiment of my invention comprises an elongated annular coil surrounding the tube envelope and extending between the target electrode and the display screen. This focusing coil provides an axially polarized magnetic field with its flux lines extending parallel to the axis of the tube in the image section thereof thus effectively focusing the photoelectrons emitted from the photocathode material layer onto the storage screen and the display screen.

It is accordingly an object of my invention to provide an improved storage cathode ray tube.

Another object of my invention is to provide an improved signal-to-image storage cathode ray tube.

A further object of my invention is to provide an improved signal-to-image storage cathode ray tube in which the resolution is improved.

A still further object of my invention is to provide an improved signal-to-image storage cathode ray tube in which the writing electron gun is located along the axis of the tube thereby eliminating distortion of the written image found in prior tubes having off-set writing guns.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic cross-sectional view of a signal-to-image storage cathode ray tube incorporating one embodiment of my invention, and

Fig. 2 is a fragmentary schematic cross-sectional view illustrating another embodiment of my invention.

Referring now to Fig. 1, my improved signal-to-image storage cathode ray tube, generally identified as **1**, comprises an enclosing envelope **2** having a conventional phosphor display screen **3** formed at one end thereof. A conventional high velocity writing electron gun assembly **4** is positioned within elongated neck **5** of envelope **2** and comprises a suitable cathode **6**, a control grid **7** and conventional beam forming and accelerating elements **8**, **9** and **10**, as is well known in the art. Suitable potentials are applied to the accelerating and beam forming elements **8**, **9** and **10** by means of external leads **11** and **12** and the high velocity electron writing beam **13** produced by the electron gun assembly **4** is scanned in the desired pattern by means of horizontal and vertical electrostatic deflection plates **14** and **15** connected respectively to external leads **16** and **17**; it will be readily understood that while electrostatic deflection elements **14** and **15** are shown, conventional magnetic deflection of electron beam **13** may be equally advantageously employed. Cathode **6** of electron gun assembly **4** is connected to a suitable source of cathode potential $-E_c$ by external lead **18** while the control grid **7** is connected to switch **19** by means of external lead **20**. Switch **19** has a first position **21** connected to a suitable source of control grid biasing potential $-E_g$ by means of suitable resistor **22** and also to a source of electrical input signals by means of coupling capacitor **23**. Switch **19** has a second position **24** connected to external lead **18** of cathode **6**, as shown. A conventional conductive coating **25** is formed on the inner wall of envelope **2** forwardly of electron gun assembly **4** and deflection elements **14** and **15**, conductive coating **25** being connected to a suitable source of potential by external lead **26** and thus serves to accelerate electron beam **13**, as is well known in the art.

In accordance with my invention, I provide a target electrode assembly **27** within envelope **2** and spaced from display screen **3**, target electron assembly comprising a phosphor layer **28** supported on a thin transparent film **29** which in turn supports a layer **30** of photocathode material. It will now be seen that electron beam **13** is caused to scan the phosphor layer **28** by means of deflection elements **14** and **15**; impingement of electron beam **13** on the phosphor layer **28** causes it to fluoresce in turn exciting the photocathode material layer **30** causing it to emit photoelectrons toward display screen **3**. The phosphor layer **28** and photocathode material layer **30** are preferably connected together by means of external leads **31** and **32** and in turn connected to switch **33**. Switch **33**, which may be ganged with switch **19**, as shown by the dashed line **34**, also has two positions, its first position **35** connecting phosphor layer **28** and photocathode material layer **30** to a suitable source of external potential, such as -500 volts by external lead **36**, and its second position **37** connecting phosphor layer **28** and photocathode material layer **30** to another suitable source of external potential, such as ground **39**, as shown.

A charge storage screen **40** is provided interposed between the target electrode **27** and display screen **3**, storage screen **40** preferably comprising a fine mesh metal screen **41** having secondary emissive insulator material **42** coated on its surface facing the photocathode material layer **30**. Fine mesh metal screen **41** has in external lead **43** connected to switch **44** which in turn has two positions **45** and **46** adapted respectively to connect the fine mesh metal screen **41** to two appropriate potentials, such as $+15$ volts and $+18$ volts respectively, as shown. A fine mesh metal secondary electron collector screen **47** is provided closely spaced from the insulator surface **42** of the storage screen **40** and is connected to a suitable source of potential by means of external lead **48**. Ring elec-

trodes 49, 50 and 51 are provided between the target electrode 27 and collector screen 47 for establishing a uniform accelerating field for the photoelectrons emitted from photocathode material layer 30, ring electrodes 49, 50 and 51 being connected to appropriate progressively higher voltages by means of external leads 52, 53 and 54. Suitable ring electrodes 55 and 56 for the same purpose are disposed between storage screen 40 and display screen 3, being again connected to suitable progressively higher voltages by external leads 57 and 58.

In order to focus the photoelectrons emitted from photocathode material layer 30 onto the storage screen 40 and also onto the display screen 3, a suitable focusing coli 60 is provided surrounding envelope 2 and extending between the target electrode 27 and display screen 3, focusing coil 60 being adapted to be connected to a suitable source of energizing potential by means of external leads 61.

In operation and during writing of an input signal, switches 19 and 33 are in their first positions 21 and 35 respectively connecting control grid 7 of electron gun 4 to the source of input signals and to an appropriate grid bias potential and connecting phosphor material layer 28 and photocathode material layer 30 to a source of potential highly negative with respect to the potential impressed on the fine mesh metal screen 41 of the storage screen 40, i.e., +15 volts, with switch 44 in its position 45. The writing beam 13 from electron gun 4 is thus caused to scan the phosphor layer 28, the intensity of beam 13 being varied responsive to the input signal applied to control grid 7 of electron gun 4 by coupling capacitor 23. The spot caused by impingement of electron beam 13 on the phosphor layer 28 causes corresponding fluorescence of the phosphor layer, the light from this fluorescence being transmitted through the transparent film 29 thus exciting the photocathode material layer 30 to emit photoelectrons toward the storage screen 40. The photoelectron image emitted from the photocathode material layer 30 is focused onto the insulator layer 42 of the storage screen 40 by the magnetic field established by focusing coil 60, impingement of the photoelectrons on the insulator layer 42 producing secondary electrons which are collected by the secondary emission collector screen 47. A charge pattern or image is thus formed on the insulator layer 42 of storage screen 40 proportional to the density of the photoelectron image and thus in turn corresponding to the electrical signal impressed on control grid 7 of electron gun 4; the charge image "written" onto the insulator layer 42 of storage screen 40 cannot easily leak off since the layer 42 is a good insulator.

In order to "read-out" the stored image on the insulator layer 42 of storage screen 40, switches 19 and 33 are moved to their second positions 24 and 37 respectively disconnecting the input signal source and control grid biasing voltage from the control grid 7 and connecting it instead to the cathode 6, and impressing a potential, i.e., ground on phosphor layer 28 and photocathode material layer 30 which is only slightly negative with respect to the potential impressed on the fine mesh metal screen 41 of storage screen 40, i.e., +15 volts. The electron beam 13 continues to scan the phosphor layer 28, now having uniform intensity by virtue of connection of the control grid 7 to cathode 6. The resulting fluorescence of the phosphor layer 28 caused by impingement of the uniform intensity electron beam 13 thereon excites the photocathode material layer 30 to emit photoelectrons, however, by virtue of its only slightly negative potential with respect to the storage screen 40, the photoelectrons now emitted from the photocathode material layer 30 now approach the insulator layer 42 with very low energy. A uniform flood beam of photoelectrons is thus provided from the photocathode material layer 30 during the read-out operation, these low velocity photoelectrons passing through the openings in the storage screen 40, being modulated responsive to the incremental charges

on the insulator surface 42. The low velocity photoelectrons which pass through the openings in the storage screen 40 are focused onto the phosphor display screen 3 by the focusing coil 60, the resulting light image on the display screen 3 being a replica of the charge image which was formed on the insulator layer 42.

The charge image on the insulator layer 42 may be obliterated, i.e., erased, by momentarily increasing the potential of the entire surface by a few volts. This is accomplished by switching the potential of the fine mesh screen 41 of storage screen 40 by means of switch 44 from its original potential of +15 volts to a slightly higher potential of +18 volts. With switches 19 and 33 still in their second positions, i.e., establishing the circuit connections for read-out with the signal input circuit and source of control grid bias potential removed from control grid 7 of electron gun 4 and with the phosphor layer 28 and photocathode material layer 30 at ground potential, the photoelectron beam emitted by the photocathode layer 30 will now approach the insulator surface 42 with slightly higher energy occasioned by the increase of the potential of the fine mesh metal screen 41 from +15 volts to +18 volts. The photoelectrons which do not pass through the openings in the storage screen 40 will strike the insulator surface 42 and will charge it in the negative sense since the secondary emission will be negligibly small for the low energy photoelectrons. This negative charge obliterates the former positive charge returning the insulator surface 42 to its original potential in readiness for receiving a new charge in the next writing operation by returning switches 19 and 33 to their original positions 21 and 35 and switch 44 to its original position 45.

With the phosphor layer 28 and photocathode material layer 30 connected together by external leads 31 and 32, as shown, when the potential applied thereto is increased by moving switch 33 from its first position 35 to its second position 37, the electron beam 13 will no longer be focused on the phosphor layer 28. This fact is, however, of no consequence, and may even be desirable since the purpose of the electron beam during the read-out operation is to excite the phosphor layer 28 uniformly over its entire area thereby uniformly to excite the photocathode material layer 30 to provide a uniform low velocity beam of photoelectrons during viewing and erasing.

Turning now to Fig. 2 in which like elements are illustrated by like reference numerals, the uniform low velocity flood beam electrons from the photocathode material layer 30 may be obtained by flooding the layer 30 with light. Thus, in the illustrated embodiment, electric lamps 63 and 64 are provided outside of the envelope 2 and arranged to illuminate the surface of the transparent phosphor layer 28; this requires that the wall section 65 of envelope 2 be transparent, however, this is readily accomplished by means of the use of a transparent conductive coating 25 as is well known in the art. Lamps 63 and 64 are energized through leads 66 and 67 connected respectively to a suitable source of power by means of switch 68. Switch 68 may be ganged with switches 19 and 33 so that it is closed in the second positions of switches 19 and 33. Thus, during read-out and erasing, when switches 19 and 33 are in their second positions, as hereinabove described, switch 68 will be closed thus illuminating lamps 63 and 64 in turn uniformly illuminating photocathode material layer 30 through transparent phosphor layer 28, uniformly and instantaneously exciting all of photocathode material layer 30 thereby to provide the low velocity flood beam of photoelectrons directed toward and through the storage screen 40 and onto the display screen 3 to provide the visual display. Scanning of the phosphor layer 28 by electron beam 13 may continue during illumination by lamps 63 and 64 since impingement of electron beam 13 on phosphor surface 28 will have no appreciable effect in view of the overall illumination of photocathode 30 by lamps 63 and 65.

While the embodiment of Fig. 1 may in some in-

stances be preferred since no external lamps are required, the embodiment of Fig. 2 may be advantageous since the entire photocathode material layer **30** is instantaneously illuminated during viewing and erasing rather than being illuminated by the writing spot exciting a raster as in the embodiment of Fig. 1. Thus, it is to be expected that with the embodiment of Fig. 2, higher brightness and faster erasing will result since the charge per element of cathode area emitted from the photocathode material layer **30** in the time T required to scan a raster would be iT whereas it would be only

$$i\frac{aT}{A}$$

in the embodiment of Fig. 1 with the scanned raster where A is the area of the raster and (a) the area of the light spot which traces the raster on the phosphor layer **28** thus providing a corresponding emission of photoelectrons from the photocathode material layer **30** in raster form.

It will be readily seen that with both embodiments of my invention, the magnetic focusing coil **60** is axially polarized, as indicated in Fig. 1, thus providing a magnetic field with its lines of flux extending between target electrode **27** and display screen **23** being essentially parallel to the axis of the tube, thus uniformly focusing the photoelectrons from the photocathode material layer **30** onto and through the storage screen **40** and onto the display screen **3** and in turn providing a focused display image with the resolution of prior storage image converter tubes and with the brightness and contrast capabilities of prior signal-to-image storage tubes.

It will further be seen that with my improved storage cathode ray tube construction, the writing electron gun is disposed along the axis of the tube thereby eliminating the distortion encountered in prior signal-to-image storage tubes in which the writing gun is off-set with respect to the axis of the tube.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

What is claimed is:

1. A direct viewing storage cathode ray tube comprising: a phosphor display screen; a planar target electrode spaced from said display screen and including a phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited by fluorescence of said phosphor layer; a perforate charge storage screen arranged intermediate said target electrode and said display screen; electron gun means arranged to scan an electron beam over said phosphor layer thereby causing fluorescence of the same and exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen; means for causing said photocathode material layer to emit low velocity photoelectrons toward said storage screen and magnetic focusing means arranged to focus said photoelectrons onto said charge storage screen and to focus an electron image of the charge storage screen onto said display screen.

2. A direct viewing storage cathode ray tube comprising: a phosphor display screen; a planar target electrode spaced from said display screen and including a phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited by fluorescence of said phosphor layer; a perforate charge storage screen positioned intermediate said target electrode and said display screen; electron gun means including a signal input circuit adapted to be connected to a source of input signals, said electron gun means being arranged at times to scan an electron beam responsive to said input signals over said phosphor layer thereby causing fluorescence of the same and exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen whereby a charge image is formed on said storage screen corresponding to said input signals; and means arranged for at other times exciting said photocathode material layer to emit a uniform flood beam of low velocity photoelectrons toward said storage screen whereby said low velocity photoelectrons pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and magnetic focusing means arranged between said target electrode and said display screen for focusing said high velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

3. A direct viewing storage cathode ray tube comprising: a phosphor display screen; a planar target electrode spaced from said display screen and including a phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited by fluorescence of said phosphor layer; a perforate charge storage screen positioned intermediate said target electrode and said display screen; an electron gun arranged to scan an electron beam over said phosphor layer thereby causing fluorescence of the same; circuit connections arranged during first intervals to impress an input signal on said electron gun and to impress a first predetermined potential on said target electrode so that said electron gun scans said phosphor layer with an electron beam responsive to said input signal thereby exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen to form a charge image thereon responsive to said input signal; said circuit connections being arranged during second intervals to disconnect said input signal from said electron gun and to excite said photocathode material layer and impress another predetermined potential thereon so that said photocathode material layer emits a uniform flood beam of low velocity photoelectrons toward said storage screen whereby said low velocity photoelectrons pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and magnetic focusing means extending between said target electrode and said display screen for focusing said high and low velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

4. The combination of claim 3 in which said first predetermined potential is highly negative with respect to the potential of said storage screen and said other predetermined potential is slightly negative with respect to the potential of said storage screen.

5. A direct viewing storage cathode ray tube comprising: a phosphor display screen; a planar target electrode spaced from said display screen and including a phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited by fluorescence of said phosphor layer; a perforate charge storage screen positioned intermediate said target electrode and said display screen; an electron gun arranged to scan an electron beam over said phosphor layer thereby causing fluorescence of the same; circuit connections arranged during first intervals to impress an input signal on said electron gun and to impress a predetermined potential on said target electrode so that said electron gun scans said phosphor layer with an electron beam responsive to said input signal thereby exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen to form a charge image thereon responsive to said input signal; said circuit connections being arranged during second intervals to disconnect said input signal from said electron gun and to impress another predetermined potential on said photocathode material layer so that said electron gun scans said phosphor layer with a uniform intensity electron beam

whereby said photocathode material layer emits a uniform flood beam of low velocity photoelectrons toward said storage screen whereby said low velocity photoelectrons pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and magnetic focusing means extending between said target electrode and said display screen for focusing said high velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

6. A direct viewing storage cathode ray tube comprising: an enclosing envelope; a phosphor display screen at one end of said envelope; a planar target electrode in said envelope spaced from said display screen and including a phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited responsive to fluorescence of said phosphor layer; a charge storage screen in said envelope intermediate said target electrode and said display screen and including an insulator layer facing said photocathode material layer; an electron gun in said envelope at the other end thereof arranged to scan an electron beam over said phosphor layer thereby causing fluorescence thereof; a signal input circuit; switching means arranged in a first position to connect said signal input circuit to said electron gun and to impress a potential on said photocathode material layer highly negative with respect to the potential of said charge storage screen so that said electron gun scans said phosphor layer with an electron beam responsive to said input signal thereby exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen forming a charge image on said insulator layer corresponding to said input signal; said switching means being arranged in a second position to disconnect said signal input circuit from said electron gun and to impress a potential on said photocathode material layer slightly negative with respect to the potential of said charge storage screen so that said electron gun scans said phosphor layer with a uniform intensity electron beam thereby exciting said photocathode material layer to emit a uniform flood beam of low velocity photoelectrons toward said storage screen which pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and an annular magnetic focusing coil surrounding said envelope and extending between said target electrode and said display screen for focusing said high and low velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

7. A direct viewing storage cathode ray tube comprising: an enclosing envelope; a phosphor display screen at one end of said envelope; a planar target electrode in said envelope spaced from said display screen and having a transparent film with a phosphor layer on one side thereof and a layer of photocathode material on the other side facing said display screen and arranged to be excited responsive to fluorescence of said phosphor layer, said phosphor and photocathode material layers being electrically connected together; a charge storage screen in said envelope intermediate said target electrode and said display screen and having a fine mesh metal screen with secondary emissive insulator material deposited thereon facing said photocathode material layer; a secondary electron collector electrode in said envelope intermediate said target electrode and said storage screen; an electron gun in said envelope at the other end thereof and including a cathode and a control grid, said electron gun being arranged to scan an electron beam over said phosphor layer; a signal input circuit, switching means arranged in a first position to connect said control grid to said signal input circuit and to a source of grid bias potential and to connect said phosphor and photocathode material layers to a source of potential highly negative with respect to the potential of said storage screen so that said electron gun scans said phosphor layer with an electron beam responsive to said input signal thereby exciting said photocathode layer to emit high velocity photoelectrons toward said storage screen forming a charge image on said insulator material corresponding to said input signal; said switching means being arranged in a second position thereof to connect said electron gun control grid to said cathode and said phosphor and photocathode material layers to a source of potential slightly negative with respect to said storage screen so that said electron gun scans said phosphor layer with a uniform intensity electron beam thereby exciting said photocathode material layer to emit a uniform flood beam of low velocity photoelectrons toward said storage screen which pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and an annular magnetic focusing coil surrounding said envelope and extending between said target electrode and said display screen for focusing said high and low velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

8. A direct viewing storage cathode ray tube comprising: an enclosing envelope; a phosphor display screen at one end of said envelope; a planar target electrode in said envelope spaced from said display screen and including a transparent phosphor layer and a layer of photocathode material facing said display screen and arranged to be excited responsive to fluorescence of said phosphor layer; a charge storage screen in said envelope intermediate said target electrode and said display screen and including an insulator layer facing said photocathode material layer; an electron gun in said envelope at the other end thereof arranged to scan an electron beam over said phosphor layer thereby causing fluorescence thereof; a signal input circuit; switching means arranged in a first position to connect said signal input circuit to said electron gun and to impress a potential on said photocathode material layer highly negative with respect to the potential of said charge storage screen so that said electron gun scans said phosphor layer with an electron beam responsive to said input signal thereby exciting said photocathode material layer to emit high velocity photoelectrons toward said storage screen forming a charge image on said insulator layer corresponding to said input signal; a flood light source disposed outside of said envelope and arranged uniformly to illuminate through a transparent wall of said envelope the side of said phosphor layer remote from said photocathode material layer; said switching means being arranged in a second position to disconnect said signal input circuit from said electron gun and to impress a potential on said photocathode material layer slightly negative with respect to the potential of said storage screen and to illuminate said flood light source whereby said photocathode material layer is excited to emit a uniform flood beam of low velocity electrons toward said storage screen which pass through said storage screen being modulated by the charge image thereon to provide a visual image on said display screen corresponding to said charge image; and an annular magnetic focusing coil surrounding said envelope and extending between said target electrode and said display screen for focusing said high and low velocity photoelectrons onto said storage screen and said low velocity photoelectrons onto said display screen.

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