May 5, 1959

D. GABOR

2,885,595

CATHODE RAY TUBES

Filed Nov. 21, 1956

3 Sheets-Sheet 1

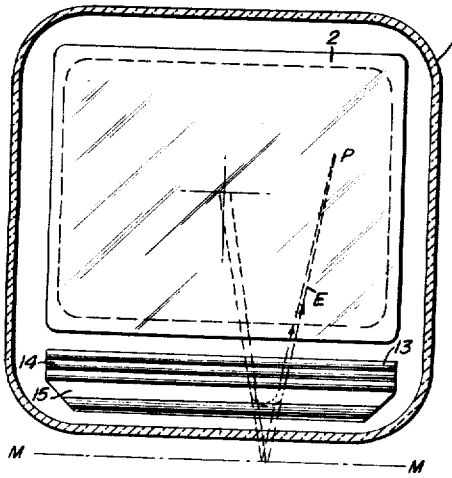


FIG. 1

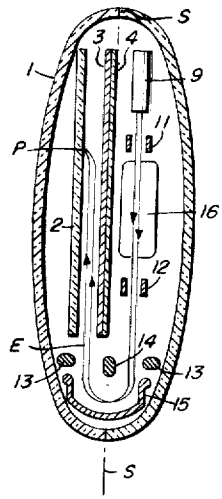


FIG. 2

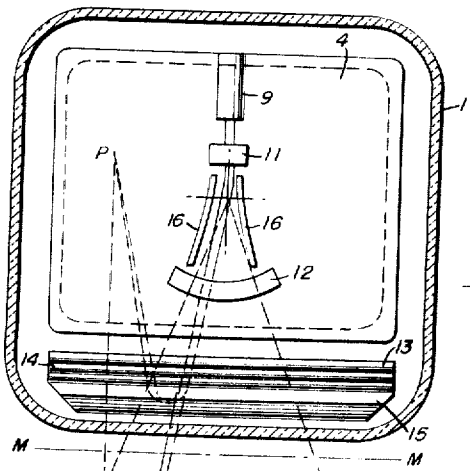


FIG. 3

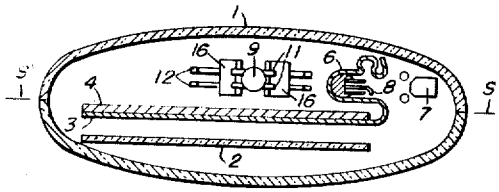
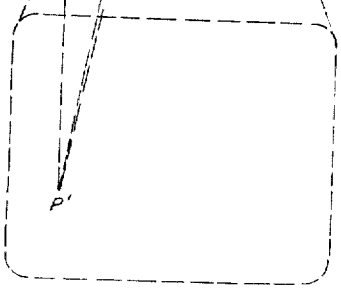


FIG. 4



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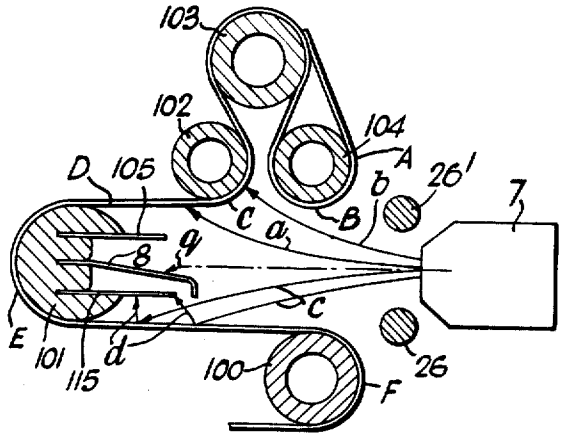


FIG.7.

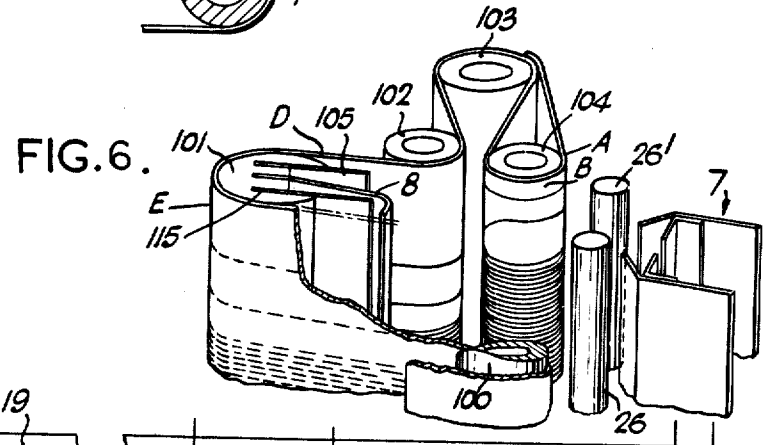


FIG.6.

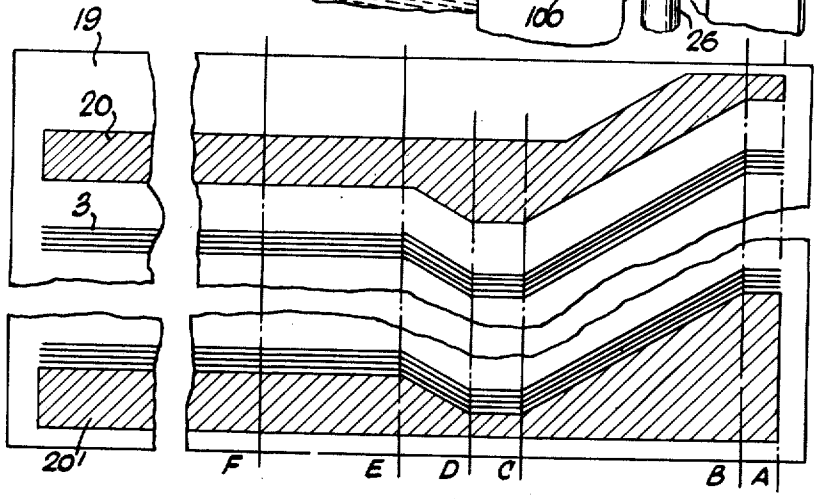


FIG.5.

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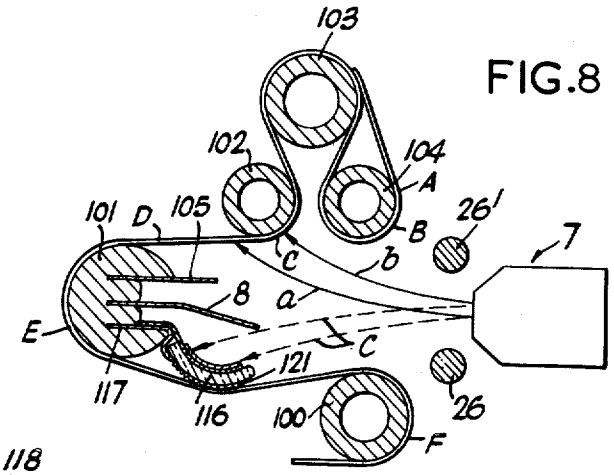
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FIG.8.



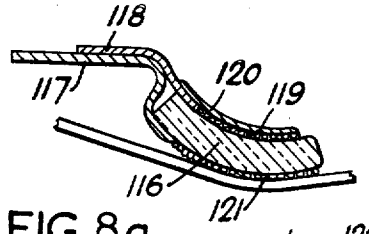


FIG.8a.

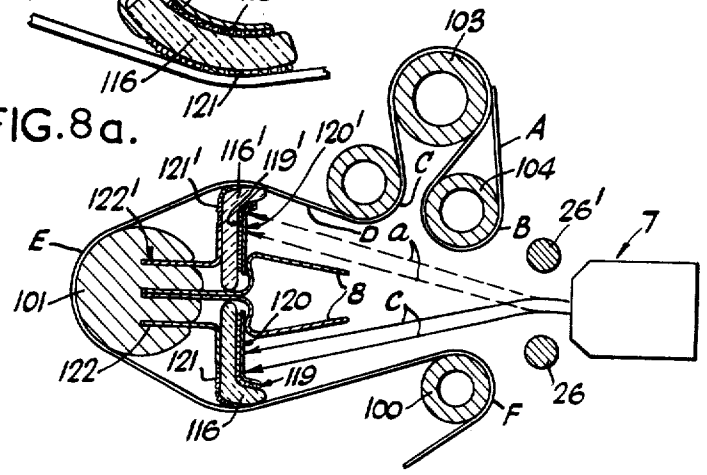


FIG.9.

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United States Patent Office 2,885,595 Patented May 5, 1959

2,885,595

CATHODE RAY TUBES

Dennis Gabor, London, England, assignor to National Research Development Corporation, London, England, a corporation of Great Britain

Application November 21, 1956, Serial No. 623,666

Claims priority, application Great Britain November 23, 1955

14 Claims. (Cl. 315—21)

The present invention relates to cathode ray tubes and more particularly to tubes of the kind described in the specification of copending application Serial No. 549,712, filed 29th November 1955, now Patent No. 2,795,729, issued June 11, 1957. In that specification, there is described a form of cathode ray tube in which the electron beam which serves to produce a representation on the fluorescent screen is set up in a plane parallel to the plane of the screen and is deflected in this plane by conventional X-deflection means, and an end portion of the beam is turned over towards and into impact with the screen by means of an electrostatic field set up between the screen and an array of conductors in a plane parallel to and facing the screen. The electrostatic field is caused to effect this deflection of the end of the beam at varying distances across the screen so as to produce scanning of the beam in the Y dimension by setting up a wave of discharge which travels across the array of conductors. In order to set up, for example, a television raster on the screen of such a tube a wave of discharge is caused to run across the array of conductors with the speed required for the television frame scan. Between frames it is necessary to re-charge the array. These two functions are performed according to the description in the above numbered patent specification by means of an organ termed the scanning valve. This organ comprises an array of conductors which is preferably a continuation of the conductors of the main deflection array, and with which is associated an electron gun arranged to produce a discharge of electrons towards the scanning valve array in the form of a ribbon beam which extends over the full height of the array. For the purpose of the frame scan, a portion of the electron beam is deflected into contact with the electrode array so as to discharge a narrow zone of the array (called the scanning zone) and this zone is made to run across the array by the introduction into the configuration of the array conductors of a stagger which has the effect of bringing portions of the discharged conductors opposite to portions of the still fully charged conductors. A transverse potential gradient is thus set up, effective to deflect a portion of the electron beam, at a position which varies progressively as successive conductors are discharged, towards the array so as to discharge the conductors. For re-charging the array, it is arranged that the ribbon electron beam of the scanning valve shall strike the array over the whole of its length simultaneously with an electron energy great enough to produce secondary electron emission at a secondary/primary ratio greater than 1. An electrode brought to a sufficiently high potential is positioned to collect the secondary electrons so that the array tends to stabilise itself at the potential of this high potential electrode. By suitable control of the potential on this high potential electrode, the potential of the array can be drawn up to the maximum voltage in the tube; this constitutes its charged condition.

The operation of the scanning valve as described in the prior application, above referred to, leads to some difficulty from the point of view of circuit design since it is necessary to maintain between the various electrodes of the scanning valve appropriate potential differences for satisfactory secondary electron emission to take place, while progressively raising the electrode which collects the secondary electrons to the maximum HT voltage. It is the intention of the present invention to provide alternative forms of scanning valve of the kind and for the purpose above discussed, which will enable simpler circuits to be employed for operation of the tube.

According to the invention in one aspect, a scanning valve, of the kind above described, is provided with a bucket electrode positioned to receive the undeflected emission from an associated electron gun, means associated with one portion of the scanning valve electrode array for controlling discharge of the said array under the influence of electron bombardment from said gun, means associated with a different portion of said array for controlling charging of said array under the influence of electron bombardment from said electron gun, and means for deflecting the emission from said electron gun to render one or other of said charge and discharge controlling means effective.

According to one feature of the invention, control of the discharge of the scanning valve conductor array is achieved by mounting the conductors of the array in a configuration adapted to produce deflection of a portion of the electron stream towards one region of said conductors and means for suppressing the emission of secondary electrons from said region under the influence of electron bombardment; the means for controlling the charging of the array comprises an electrode positioned to collect secondary electrons emitted by a region of said array under the influence of electron bombardment in combination with means for deflecting said electron stream towards said region.

According to the invention in another aspect, a scanning valve, of the kind above described, comprises means associated with the scanning valve array adapted to provide a conductive coupling of said array to a source of re-charging potential only under the effect of electron bombardment, and means for deflecting an electron stream towards said means to render said conductive coupling effective.

According to a feature of the invention in this latter aspect the means for controlling the re-charging of the array comprises a coupling member including a region of photo-conductive material adapted to provide effective conductive coupling of the high potential re-charging source to said array only under the influence of light irradiation, and means for producing illumination of said photo-conductive layer under the influence of electron bombardment so as to reduce the resistance of said photo-conductive layer and effectively couple the array to the re-charging potential source for the purpose of re-charging the array.

According to another feature of the invention in this aspect, the control means for controlling the discharge of the array in a scanning zone may comprise a photo-conductive layer adapted to be irradiated by fluorescence from a zone of electron bombardment produced in the scanning wave so as to provide in the scanning zone a discharge path between the array and a low voltage source.

In order that the invention may be more clearly understood, some embodiments thereof, for use in a cathode ray tube adapted to provide a television display, will now be described with reference to the accompanying drawings, in which:

Figures 1, 2, 3 and 4 are a front view, a side view, a rear view and a plan view, respectively, all partly sectioned and somewhat diagrammatic in character, of one

form of cathode ray tube embodying the present invention,

Figure 5 is a developed view of an electrode array for use in a scanning valve according to this invention,

Figure 6 is a partial, perspective view of the scanning valve assembly,

Figure 7 is a cross-sectional view of one form of scanning valve according to the invention,

Figure 8 is a cross-sectional view similar to Figure 7 of an alternative form of scanning valve according to the invention,

Figure 8*a* is an enlarged view of a portion of the scanning valve assembly of Figure 8 and

Figure 9 is a cross-sectional view of a further form of scanning valve according to the invention.

The cathode ray tube shown in Figures 1–4 is similar in construction and mode of operation to that disclosed in the patent application referred to above, and includes a vacuum envelope **1** which consists of glass on the side from which the screen **2** is viewed, while the other parts may be made of glass or metal. The fluorescent screen **2** is in the form of a phosphor coating on a sheet of suitable material such as glass, or glass cloth suitably tensioned, and may be backed with the now widely used metallic layer. Facing the screen, and at a relatively small distance from it, is arranged the scanning array **3** the details of which are shown in Figure 5 and described hereinafter. The array is backed, at least in part, by the metal plate **4** which may be used as support for the rear array but is insulated therefrom and constitutes the common capacitive backing of the array. The scanning array is folded round the backing plate **4**, and into a loop **6** which forms the outer electrode of the scanning valve, whose grid **7** and collecting electrode **8** are also shown, and which will be more fully described later.

The electron beam E is formed by the electron gun **9**, which may be of conventional design, and is not shown in detail. In the drawings the electron beam E is shown as if it were astigmatic; focused at the point P in the plane of Figure 1, while in the plane of Figure 2 it is shown collimated by the gun, i.e. focused at infinity. In this plane the beam is brought to a focus only by the local deflecting field, as described in my above-mentioned patent application Serial No. 549,712.

The line scan, that is to say the deflection parallel to the fluorescent screen, is effected by a pair of electrostatic deflecting plates **16, 16**.

Two pairs of small deflector electrodes **11** and **12** are provided which operate in opposition to one another so as to displace the beam parallel to itself. For a tube operating only in black and white these electrodes are given fixed potentials adjusted to direct the electron beam exactly into the narrow gap between the screen **2** and the array **3**, thus correcting for small inaccuracies in the mounting of the electron gun relative to said gap. In color tubes they have the additional function of color control.

In this tube, the picture beam electron gun **9**, deflector electrodes **11** and **12** and line scanning deflection plates **16, 16** are arranged at the back of the scanning array **3** and the backing plate **4**, being so positioned as to direct the beam downwardly into an electron lens or mirror which reverses the beam and causes it to pass upwardly between the array **3** and the screen **2**. In the form illustrated, the lens comprises two cylindrical electrodes **13, 13** placed one on each side of a third electrode **14**, also cylindrical, located in the symmetry plane S—S. All three of these electrodes are connected to a positive potential, preferably the highest positive potential in the tube, V_m. Associated with the electrodes **13, 13** and **14** is a hollow cylindrical electrode or trough **15**, which is positioned symmetrically beneath the other electrodes and is kept at or near the potential of the cathode of the picture beam electron gun **9**. These electrodes are so designed that the electric field between them brings a parallel electron beam to a focus in the symmetry plane, and the emerging beam is again collimated, all as described in the previously mentioned application Serial No. 549,712.

As shown in Figures 1 and 3, the effect of the electron lens **13, 14, 15**, viewed in the plane of these drawings, is the same as specular reflection on a line M—M, which is well outside the physical boundaries of the lens. Thus the deflectors **16, 16** must be so adjusted as to scan the mirror image of the fluorescent screen relative to said line M—M, as illustrated in Figure 3.

Referring now to Figure 5, this illustrates the electrode structure used for the scanning array of the cathode ray tube of Figures 1–4, combined with the array which forms part of the scanning valve. It consists of a pattern of metallic lines formed, for example, by printing techniques such as are used for the production of so-called printed circuits, on a flexible backing of insulating material such as glass cloth impregnated with silicone varnish. The part of the array to the left of the line F in the drawing is the part which faces the cathode ray tube screen and which produces a deflection field running across the array for deflecting the picture beam towards the screen at progressively varying levels. The deflection field occupies a narrow zone extending horizontally across the screen (that is parallel to the conductors **3**) and extends in the vertical direction over a few of the conductors. It will be understood that the conductors **3** occupy the whole of the vertical extent of the screen, only a few having been shown for the sake of clarity. At the top of the array is an electrode **20**, which serves to start the scanning operation, while at the bottom of the array is an electrode **20'**, which receives the picture beam at the termination of the frame scan.

The part of the array to the right of the line F, forms the scanning valve array and this is wound on to supporting insulators shown in perspective in Figure 6 and Figures 7, 8 and 9 in cross-section. These insulators **100, 101, 102, 103** and **104** are in the form of rods or tubes which extend the full height of the array and around which the array is wrapped into the configuration shown. The positions of lines A, B, C, D, E and F, marked on Figure 5, are shown also in the cross-sectional views. It will be appreciated that the loop of the array passed round the tube **103** merely serves to absorb some of the length of the array between B and C, which is provided to avoid making the slope of the conductors in this region excessive, while achieving the degree of stagger required.

Mounted adjacent the mouth of the channel-shaped envelope formed by the conductors are two rod electrodes **26** and **26'**, the purpose of which will be mentioned later, and an electron gun **7** shown only schematically but in fact including a cathode and heater therefor extending the full height of the scanning valve and a control electrode having a slit aperture through which a ribbon beam of electrons is directed into the scanning valve envelope. Within the envelope, mounted on the rod **101** are three electrodes, a collector or bucket electrode **8**, a suppressor electrode **105** and a further electrode (**115** in Figure 7) the purposes of which will be described later.

From a consideration of the drawings it will be apparent that the portions of the conductors between lines A and B, in the completed structure, lie opposite a portion of the conductors between lines E and F across the mouth of the channel-shaped envelope of the scanning valve. It will thus be seen that a vertical stagger is introduced between these facing portions of the conductors so that the portions between A and B of the uppermost conductors find themselves opposite the electrode **20**, while the portions between A and B of the lower conductors find themselves opposite portions of other conductors lying generally above them in the array. As explained in the prior patent specification, above referred to, this stagger has the effect that a transverse electrostatic field is set up between the electrode **20** on one side of the channel-shaped envelope formed by the conductors and the top few con-

ductors on the other side. This serves to deflect electrons from the electron gun **7**, in a narrow zone at the top of the array, to one side of the array so as to strike it in the region between C and D. Typical electron trajectories are shown at *a* and *b*. The electrons thus deflected towards the array serve to discharge the conductors in a narrow zone, called the scanning zone, which progresses down the array with the speed of the frame scan as progressively lower conductors are discharged and deflection of the electrons takes place at successively lower levels. Secondary electrons emitted from the array under the effect of this bombardment are returned to it by the action of suppressor electrode **105** which is maintained at a suitable low potential.

In regions of the scanning valve outside the deflection zone, electrons from the electron gun pass straight through to the bucket electrode **8** a typical trajectory being shown at *q*. These are the conditions in the scanning phase. At the end of the scanning phase it is necessary to re-charge the conductors of the array to the full H.T. voltage. This re-charging is called the flyback phase. During the scanning phase, the rod electrodes **26, 26'** are maintained both at the same potential so as not to influence the electron trajectories. For the re-charging, or flyback, however, the potential on the electrode **26'** is lowered, or that on **26** is raised, or both, so as to deflect the electron stream from the electron gun towards the scanning array in the region between E and F, as shown by the typical trajectories *c*. The voltage between the electron gun and the array is arranged to be, throughout the phase, within the range which ensures that secondary emission from the array will take place at a ratio of secondary electrons to primary electrons greater than 1:1. To collect the secondary electrons, there is provided a further electrode **115**, which is maintained permanently at high potential e.g. the maximum potential used in the tube. The array is thus caused to stabilise its potential at that of the electrode **115** and in this manner the array is charged up to the maximum positive tube potential. It will be seen that electrode **115** is screened by the collector electrode **8** so that it will not collect primary electrons emitted by the electron gun. Moreover, the electrode **115** is thereby prevented from influencing the electron trajectories in the scanning phase.

In the normal operation of tube, the bombardment of the array during the re-charging, or flyback, phase is completed before the next frame is due, and the electron stream from the scanning valve gun can then be cut off, and the electrodes **26, 26'** restored to their equipotential state. Subsequently, when the next scanning phase is due to start, the electron stream is released over the whole length of the scanning valve and over most of its length it passes straight to the collector electrode **8**. However, at the top, the electrode **20**, which is maintained permanently connected to a low potential, deflects the top portion of the beam towards the region C, D (electron trajectories *a, b*) as above described thus starting the continuous run of a voltage wave down the conductors to operate the scanning system.

In order to improve the secondary emission properties of the electrode array at the region adjacent the electrode **115**, this region may be coated with a fluorescent powder or magnesium oxide smoke, or some such surface layer of a nature such that the range of voltages over which the secondary emission ratio is greater than 1 is extended and the general level of secondary emission enhanced.

An alternative arrangement for re-charging the array, independently of secondary emission, is illustrated in Figure 8. In this arrangement, which resembles that of Figure 7 in all other respects, the electrode **115** is replaced by a member, illustrated separately in cross-section on a larger scale in Figure 8*a*. This member consists of a transparent insulating strip **116**, for example, of glass or quartz, which extends the full height of the electrode array and is so shaped and mounted as to press against the conductors of the array. It is clamped between two metallic strips **117** and **118** which together are connected to a source of high potential. On the surface of this strip which makes contact with the conductors, there is provided a layer **121** of photoconductive material such as cadmium sulphide which normally provides high insulation between the conductors of the array and the metallic holder **117**. This insulation can, however, be broken down by the effect of illumination reaching the layer through the glass or quartz strip from a fluorescent layer **119** provided on the opposite surface of strip **116**. The fluorescent layer **119** is covered by a thin aluminium layer **120** which establishes contact between itself, the layer **119** and the metallic strip **118**. The purpose of this aluminium layer is to maintain the fluorescent layer **119** at the appropriate potential, to serve as a light screen shielding the photo-conductive layer from unwanted illumination while, at the same time, enhancing the illumination produced on the photo-conductive layer by back reflection when the fluorescent layer **119** is bombarded. It also reduces the amount of unwanted light radiated into the tube.

The operation of the device requires little explanation. The metallic strips **117** and **118** are permanently connected to the maximum potential to which the electrode array is to be charged. In the absence of electron bombardment on the layer **120**, the array is effectively insulated from the high potential by the high resistance of the photo-conductive layer which extends between the array and the strip **117**. However, when, during the recharging, or flyback phase, the electron stream from gun **7** is deflected so as to bombard the layer **119**, the illumination of the layer **121** thus set up reduces the effective resistance of the photo-conductive layer so that the array is charged from the high potential source substantially to the full value of the H.T. voltage by direct conductivity.

In Figure 9, a modified arrangement is shown in which the technique described with reference to Figure 8, employing a photo-conductive layer, is employed both for discharging and re-charging the array. In Figure 9, two assemblies each resembling the assembly **116** to **121** of Figure 8 are provided, one on either side of bucket electrode **8**. On one side, the element **116** is mounted between a member **122**, which is equivalent to the element **117** of Figure 8 and makes contact with a photo-conductive layer on that side of the element **116**, and bucket electrode **8**. Layers **119** and **120** are provided, as before, but in place of element **118** connected to **117**, contact is made between the aluminium layer **120** and the bucket electrode **8**.

A similar construction is used on the other side of the bucket electrode **8**, corresponding parts having been indicated with corresponding numerals with a prime. The geometry of the system is, in this case, made such that during the scanning phase the electron stream from gun **7** is deflected in the scanning zone on to the fluorescent layer **119'** so that the photo-conductive layer **121'** is activated and the relevant array wires effectively connected to a low potential source maintained at the potential to which the array is required to be discharged. This has the advantage that the potential to which the array is discharged may be fixed and made independent of the current in the scanning valve electron beam. Outside the actual scanning zone, of course, the electron stream passes to bucket electrode **8**. As in the previous embodiment, for the re-charging phase, the potentials on electrodes **26** and **26'** are varied so as to deflect the electron stream towards the assembly **116—121** on the other side of bucket electrode **8**. The electrode **8** serves as a light shield between the two parts of the system to prevent interaction between the two.

In any of the scanning valves above described, in which a fluorescent layer is used either to enhance sec-

ondary emission or to induce photo-conductivity, it is desirable to avoid as far as possible setting up unwanted luminous radiations in the tube which may impair the picture presentation. In the embodiments of Figures 8 and 9, the aluminium layers **120** and **120'** help to reduce this effect. It is preferable, however, to employ phosphors having fluoresence in the ultra-violet region, in combination with an appropriate photo-conductor for the layers **121** and **121'**.

The use of the photo-conductive effect in the manner described with reference to Figures 8 and 9 has the advantage that the system is independent of the voltages employed and is not limited to voltages for the scanning valve electron beam at which high secondary electron emission takes place, since the fluorescent layers will emit light on bombardment by electrons at any energy level. Further, these arrangements can be made much more efficient since at high energy levels the secondary emission yield, although greater than unity, will still be small, say 1.2:1. This means that it takes five primary electrons to produce a single equivalent positive charge on the array. Against this, high energy electrons may release 100 or more photons from the luminescent material. In turn, the number of electron charges transferred per photon in the photo-conductive layer may be 100 or more. The electron current required for bringing about re-charging of the array in the flyback phase may therefore be made quite small.

It will be appreciated that other arrangements can be used according to the invention. For example, although photo-conductive layers excited by fluoresence induced by electron bombardment have been shown, it may be possible to employ layers directly influenced by electron bombardment, being substantially insulating in the absence of bombardment and conductive when bombarded. Other modifications will suggest themselves to those skilled in the art.

I claim:

1. A cathode ray tube comprising a fluorescent screen, a first electron gun for directing an electron beam adjacent and substantially parallel to said screen, means including an array of electrodes located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, and means for controlling the voltages on the electrodes of said array to control the deflection of said end portion of said electron beam, said last-named means comprising a second electron gun, a bucket electrode positioned to receive the undeflected emission from said second electron gun, means associated with a first portion of said array on one side of said bucket electrode for controlling discharge of said array under the influence of electron bombardment, means associated with a second portion of said array on the other side of said bucket electrode for controlling charging of said array under the influence of electron bombardment, and means for deflecting at least a portion of the emission from said second electron gun to one side or the other of said bucket electrode to render a selected one of said charge and discharge controlling means effective.

2. A cathode ray tube comprising a fluorescent screen, a first electron gun for directing an electron beam adjacent and substantially parallel to said screen, means including an array of electrodes located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, and means for controlling the voltages on the electrodes of said array to control the deflection of said end portion of said electron beam, said last-named means comprising a second electron gun, a bucket electrode positioned to receive the undeflected emission from said second electron gun, means associated with one portion of said array for controlling discharge of said array under the influence of electron bombardment, means associated with a different portion of said array for controlling charging of said array under the influence of electron bombardment, and means for deflecting at least a portion of the emission from said second electron gun to render a selected one of said charge and discharge controlling means effective, said charge controlling means including a control electrode adapted to be connected to a source of charging potential, a layer of normally non-conductive material electrically connected with said array and with said control electrode, and means responsive to electron bombardment for rendering said layer conductive and thereby electrically connecting said array to the source of charging potential through said control electrode.

3. A cathode ray tube comprising a fluorescent screen, a first electron gun for directing an electron beam adjacent and substantially parallel to said screen, means including an array of electrodes located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, and means for controlling the voltages on the electrodes of said array to control the deflection of said end portion of said electron beam, said last-named means comprising a second electron gun, a bucket electrode positioned to receive the undeflected emission from said second electron gun, means associated with one portion of said array for controlling discharge of said array under the influence of electron bombardment, means associated with a different portion of said array for controlling charging of said array under the influence of electron bombardment, and means for deflecting at least a portion of the emission from said second electron gun to render a selected one of said charge and discharge controlling means effective, said discharge controlling means including a control electrode adapted to be connected to a low potential source maintained at the potential to which the array is to be discharged, a layer of normally non-conductive material electrically connected with said array and with said control electrode, and means responsive to electron bombardment for rendering said layer conductive and thereby electrically connecting said array to the low potential source through said control electrode.

4. A cathode ray tube as claimed in claim 2 wherein said layer is of photoconductive material and said means for rendering it conductive under the action of electron bombardment comprises a phosphor layer positioned to receive electron bombardment by the electron stream from said second electron gun when said stream is deflected by said deflection means.

5. A cathode ray tube as claimed in claim 4 including a light permeable member having said photoconductive layer and said phosphor layer on opposite sides thereof.

6. A cathode ray tube comprising a fluorescent screen, means for directing an electron beam adjacent and substantially parallel to said screen, means including an array of electrodes located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, and means for controlling the potentials on the electrodes of said array, said last-named means comprising a pair of light permeable members, a phosphor layer on one side of each of said light permeable members, a photoconductive layer on the other side of each of said light permeable members, each of said photoconductive layers being electrically connected with the electrodes of said array, a first control electrode adapted to electrically connect one of said photoconductive layers to a source of high potential, a second control electrode adapted to electrical connect the other of said photoconductive layers to a source of low potential, a bucket electrode disposed between said light permeable members, an electron gun positioned to direct an electron stream towards said bucket electrode, first deflecting means for deflecting said electron stream towards the one of said

light permeable members, and second deflecting means for deflecting a portion of said electron stream towards the other of said light permeable members.

7. A cathode ray tube as claimed in claim 6 wherein said electrode array includes a portion of U-shaped cross section within which said light permeable members are embraced, wherein said electron gun is positioned to direct said electron stream between the limbs of said U-shaped portion, and wherein the parts of the electrodes of said array forming the limbs of said U-shaped portion are disposed in staggered relation whereby a potential difference between successive electrodes in the array sets up a transverse field across the mouth of said U-shaped portion effective to deflect a portion of said electron stream towards one of said light permeable members.

8. A cathode ray tube as claimed in claim 7 including a third control electrode positioned adjacent said electron stream between said electron gun and said U-shaped portion, adapted to deflect said electron stream towards the other of said light permeable members.

9. A cathode ray tube comprising a fluorescent screen, means for directing an electron beam adjacent and parallel to said screen, means including an array of linear conductors located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, said conductors extending into a U-section region with those parts of said conductors forming one limb of said U-section staggered in relation to those parts of said conductors forming the other limb of said U-section, an electron gun adapted to direct an electron stream between the limbs of said U-section into the embraced region within said U-section, said electron stream extending over substantially the whole height of said array, a collector electrode located within said embraced region positioned to receive the undeflected electron stream from said electron gun, a first control electrode adapted to be connected to a source of high potential, a second control electrode adapted to be connected to a source of low potential, a first high resistance photoconductive layer connecting the conductors of said array to said first control electrode, a second high resistance photoconductive layer connecting the conductors of said array to said second control electrode, a first phosphor layer positioned to illuminate said first photoconductive layer, a second phosphor layer positioned to illuminate said second photoconductive layer, and means for deflecting the electron stream from said electron gun towards said first phosphor layer.

10. A cathode ray tube comprising a fluorescent screen, means for directing an electron beam adjacent and parallel to said screen, means including an array of linear conductors located in a plane substantially parallel to said screen for deflecting an end portion of said electron beam towards said screen at varying distances thereacross, said conductors extending into a U-section region with those parts of said conductors forming one limb of said U-section staggered in relation to those parts of said conductors forming the other limb of said U-section, an electron gun adapted to direct an electron stream between the limbs of said U-section into the embraced region within said U-section, said electron stream extending over substantially the whole height of said array, a

collector electrode located within said embraced region positioned to receive the undeflected electron stream from said electron gun, a high potential control electrode positioned on one side of said collector electrode, a photoconductive layer affording connection between said conductors and said last-named electrode, a phosphor layer positioned to illuminate said photoconductive layer, means for deflecting the electron stream towards said phosphor layer, and a low potential control electrode positioned adjacent said array on the side of said collector electrode remote from said high potential control electrode.

11. A cathode ray tube comprising a substantially plane fluorescent screen, a plane array of substantially parallel linear conductors insulated from one another and arranged in a plane substantially parallel to and spaced from said screen, means for producing an electron beam passing through the space between said array and said screen in a direction transverse to the conductors of said array, means for deflecting said beam in a plane parallel to said screen, a generally U-shaped cylindrical envelope formed by continuations of the conductors of said array, an electron gun positioned outside said envelope and so arranged as to direct a ribbon-shaped beam of electrons into the mouth of said envelope, a collector electrode positioned within said envelope adapted to collect electrons issuing substantially undeflected from said gun, means for deflecting the electron stream from said gun towards the conductors of said array on one side of said collector electrode, a second electrode within said envelope positioned on the side of said collector electrode to which electrons are so deflected, adapted to collect secondary electrons emitted by said conductors when bombarded by electrons so deflected and a third electrode positioned within said envelope on the other side of said collector electrode, adapted to suppress the emission of secondary electrons from said conductors and from said collector electrode under the influence of electron bombardment.

12. A cathode ray tube as claimed in claim 11 wherein, on the side of said envelope remote from said second electrode the conductors of said array are bent into a configuration providing a region in which portions of certain of said conductors lie opposite portions of others of said conductors on the two sides of said envelope whereby a difference in the potentials on the respective conductor portions is adapted to produce a deflecting field operative to deflect electrons from said gun towards a region of said conductors on the side of said envelope remote from said second electrode.

13. A cathode ray tube as claimed in claim 11 including one or more further electrodes positioned adjacent the mouth of said envelope, adapted to produce a deflection of electrons from said electron gun towards the side of said envelope adjacent said second electrode.

14. A cathode ray tube as claimed in claim 11 wherein said collector electrode is so shaped as to shield said second electrode from primary electrons emitted by said electron gun.

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