Aug. 31, 1965 E. F. DE HAAN ETAL 3,204,142

PICKUP TUBE HAVING PHOTOCONDUCTIVE TARGET

Filed Sept. 14, 1960 3 Sheets-Sheet 1

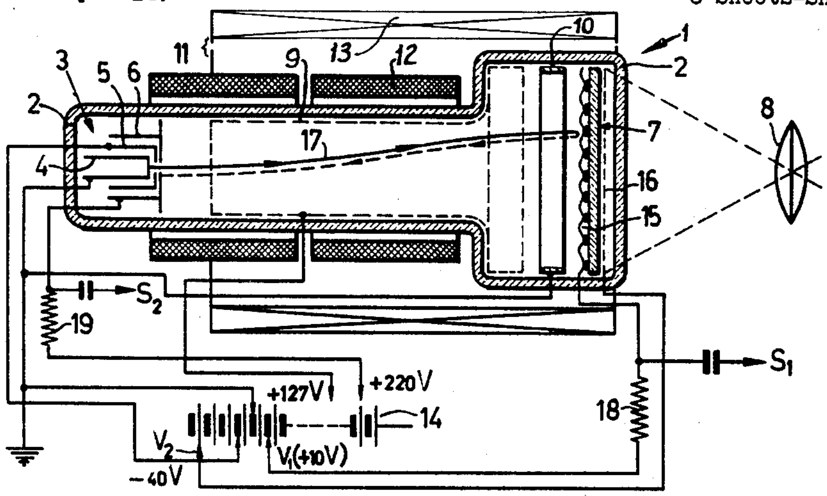

FIG.1

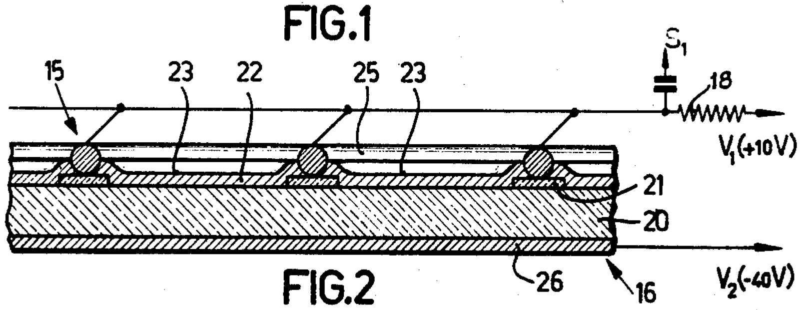

FIG.2

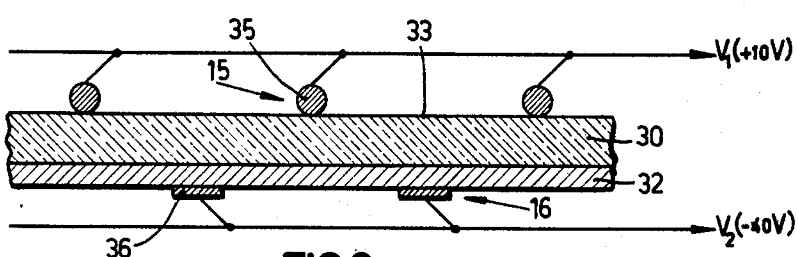

FIG.3

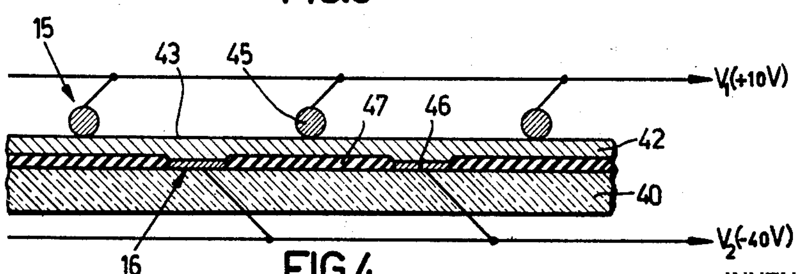

FIG.4

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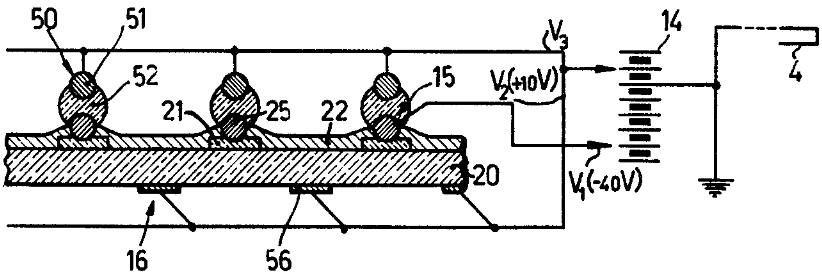

FIG.5

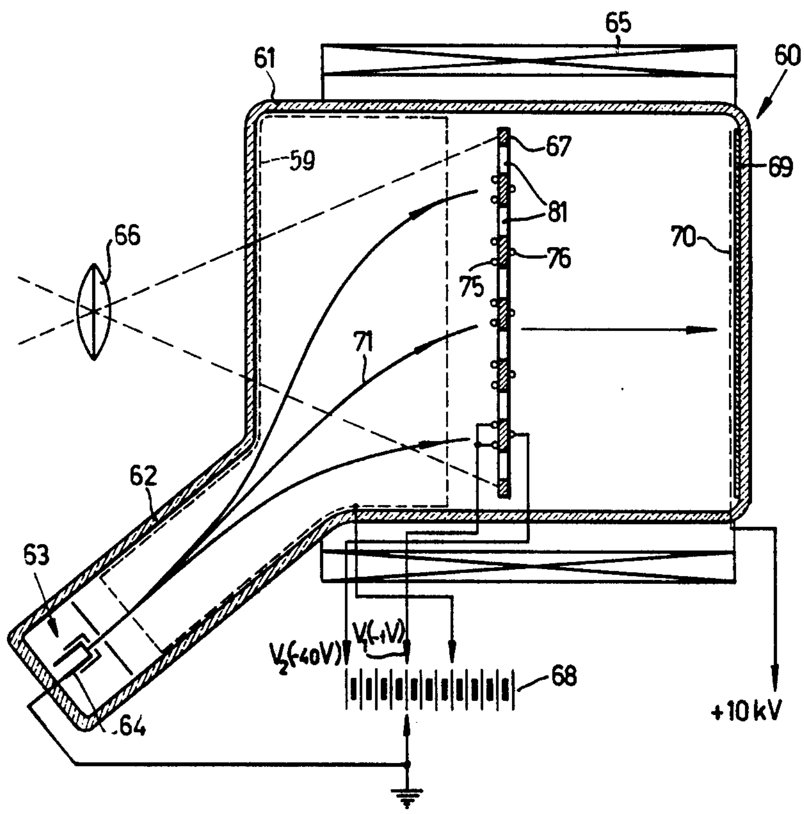

FIG.6

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PICKUP TUBE HAVING PHOTOCONDUCTIVE TARGET

Filed Sept. 14, 1960 3 Sheets-Sheet 3

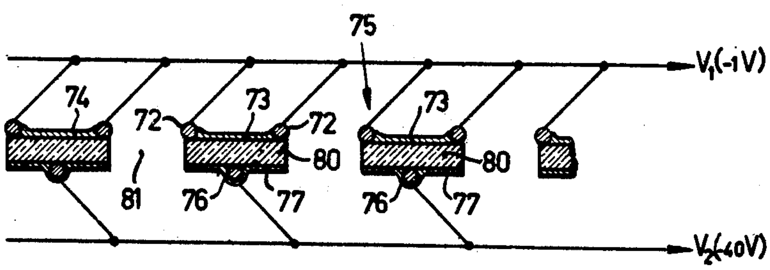

FIG.7

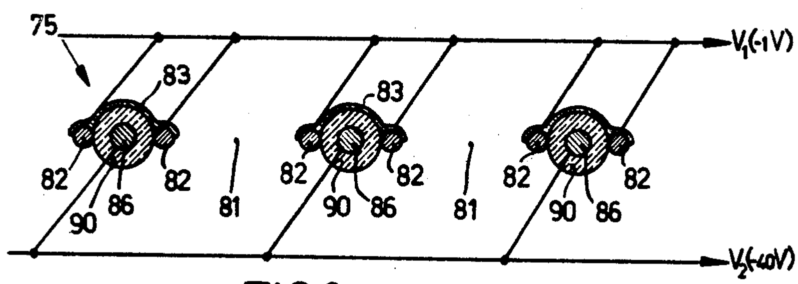

FIG.8

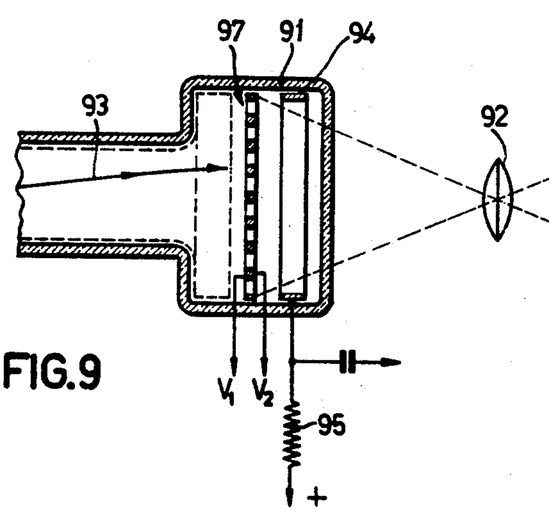

FIG.9

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3,204,142
PICKUP TUBE HAVING PHOTOCONDUCTIVE TARGET

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21 Claims. (Cl. 315—11)

Electron tubes are known which comprise an electron control-member shaped in the form of a plate or a grid and arranged in the path of an electron beam emanating from the cathode. On the control member a potential image is produced which directs the electrons of the beam towards a given collecting electrode to a degree varying with the local potential of this image, and without these electrons impinging upon the said control-member. Such an electron control-member will be termed hereinafter the control target plate.

In a known control tube comprising such an electron target, the latter consists simply of a thin plate of insulating material, on which, by means of electrons emanating from a photo-cathode, a potential image is written, while on the other side of this plate, closely in front thereof, a collecting electrode is arranged. The number of electrons of a scanning beam directed to this collecting electrode which are capable of attaining this collecting electrode will vary in accordance with the local potential of the target operating as a kind of control-grid. The electrons which do not reach this collecting electrode are repelled by the target and collected by a higher-potential electrode arranged in the proximity of the electron gun emitting the scanning beam or forming part of this gun. This tube is suitable for converting radiation images projected onto the photo-cathode into electrical image signals, which are derived from a signal resistor included in the supply conductor to one of the two said collecting electrodes. A picture tube is also known to which the target is formed by a perforated plate on which a charge image is written by means of an electron beam. This charge image determines the extent to which electrons of a wide electron beam directed towards the target are locally allowed to pass. The passing electrons are accelerated and then impinge upon a luminescent screen.

There is known an electron tube having a radiation-sensitive target, by which an optical image projected onto the target is converted into electrical image signals. The target of this tube is formed by a grid-shaped electrode, of which the metal wires forming the grid are enveloped by a material having a high resistance, on which a photo-emissive substance is provided. The wires of this target are kept at a potential which is a few volts negative with respect to a very thin metal plate arranged near this target and between the latter and the electron gun, which plate retards the high-velocity electrons of a scanning beam emanating from the electron gun. The potential image produced upon projection of an optical image onto the target allows the resultant low velocity electrons to pass to an extent varying with the local potential of this image, the passing electrons being collected by a collecting anode connected via a signal resistor to a voltage source.

The invention relates to an electron tube for converting a radiation image into electrical image signals or into a luminescent image, in which similarly to the known tube described in the foregoing paragraph, the control target plate itself is radiation sensitive. The invention has for its object to provide an electron tube of the kind set forth in which the potential image on the target is obtained by a local resistance variation thereof under the

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action of a radiation image projected onto it. The invention furthermore relates to a device comprising such an electron tube.

In accordance with the invention an electron tube of the kind set forth is characterized in that the control target plate comprises two spacially separated electrodes, of which at least one is shaped in the form of a grid. The control target further comprises elements having a resistance varying with the intensity of the radiation of the image to be converted (radiation-sensitive elements) which elements are electrically connected in series with elements having a constant resistance. The elements of one kind are in electric contact with one electrode and the elements of the other kind with the other electrode. The elements of one of these kinds have a free surface facing the cathode, on which surface the potential image directing the electrons of the electron-beam is formed. According to a further development of the invention a device comprising an electron tube according to the invention is characterized in that one of the two electrodes of the control target plate is connected to a point at a potential approximately equal to that of the cathode of the tube and the other electrode is connected to a point at a potential which is lower than that of the cathode.

It should be noted that with television camera tubes of the vidicon-type, it is known to construct the target plate, which is scanned by the cathode ray and thereby stabilized on the potential of the cathode, from series-connected resistance elements, one with a variable and the other with a constant resistance, which elements are connected to two electrodes having different potentials. In contrast to the electron tube according to the invention, the beam electrons of the known tube do reach the said elements, which is necessary since the operation of the known tube is completely based on the aforesaid stabilization of the target plate at cathode potential by means of the cathode ray. The use of a target, with which the electrons do not reach the potential image itself, provides, apart from a higher sensitivity, the advantage that the operation is not based on secondary emission phenomena, so that any variations of the surface on which the potential image is provided do not affect the operation of the device. In the known tube the required impingement of the electrons may, after some time, bring about a variation of this surface affecting the properties of the plate, which may manifest itself in a varying sensitivity.

The invention will now be described with reference to the drawing, which shows a few embodiments. In this drawing:

FIG. 1 shows diagrammatically a device for the conversion of an optical image into electrical image signals.

FIG. 2 shows, on an enlarged scale, a sectional view of a possible embodiment of the control target plate in the electron tube of the device shown in FIG. 1.

FIGS. 3, 4 and 5 show similar cross sectional views of further embodiments of the said control target.

FIG. 6 shows diagrammatically a longitudinal sectional view of an electron tube for converting an optical image into a luminescent image, the connections of the various electrodes to a voltage source being shown at the same time.

FIGS. 7 and 8 show partial sectional views, on an enlarged scale, of various embodiments of the control target plate in the tube of FIG. 6.

FIG. 9 shows diagrammatically a longitudinal sectional view of an electron tube for coverting an optical image into electrical image signals, this tube being provided with a control target of a structure as shown in FIG. 7 or 8.

The device shown in FIG. 1 comprises a cathode-ray tube 1 having a substantially cylindrical glass bulb 2. In the left-hand end thereof is arranged an electron gun

3, having a cathode 4, a control-grid 5 and an anode 6. Parallel to the right-hand end wall of the bulb 2, constituting a window, is arranged a plannar control target 7, which is provided with two electrodes 15 and 16, to be connected separately. FIGS. 2, 3, 4 and 5 each show a cross sectional view of various embodiments of this target, which embodiments will be described more fully hereinafter.

By means of an optical system 8, shown diagrammatically, an optical image may be projected onto this target. The central part of the bulb 2 is internally provided with a wall electrode 9. Between the latter electrode and the target 7 is arranged an annular retarding electrode 10, externally connected to the cathode 4. The electron tube 1 is surrounded by the conventional deflection coils 11 and 12 and a focusing coil 13. by which the electrons originating from the cathode 4 are concentrated in an electron beam 17, directed to the control target plate 7 and by applying suitable varying voltages to the deflection coils produce a scanning movement of the electron beam.

The various electrodes of the tube 1 are supplied with different direct voltages which are positive or negative with respect to the cathode 4. This is shown diagrammatically in FIG. 1 by corresponding connections of these electrodes to a common battery 14. The cathode 4 is connected to earth and is therefore at zero potential. The control-grid 5 is connected to a low negative potential, for instance about −5 v., the wall electrode 9 to a higher positive potential, for example, about +127 v. and the anode 6 to a still higher positive potential, for instance +220 v. The first electrode 15 of the two electrodes 15 and 16 of the control target 7 is connected via a signal resistor 18 to a point on the battery being at a potential V_1 and the other electrode 16 to a point at a potential V_2 relative to the cathode. With the embodiment of the control target shown in FIGS. 2, 3 or 4, V_1 is a few volts positive, for example, +10 v., whereas V_2 is larger and also negative, for example, −40 v.

The target 7, as is shown in the partial cross sectional view of FIG. 2, may consist of a thin foil 20 of conductive glass, of which the resistivity amounts from 10^9 to 10^{12} ohm cm. This glass foil of, for example, 5μ in thickness, is provided on one side with narrow strips 21 of insulating material, for example, evaporated magnesium oxide. These strips constitute a grid of rectangular meshes of a width of, for example, 30 to 50μ. These strips support a plurality of wires or linear conductors 25 arranged in a similar pattern which comprise the grid-shaped first electrode 15 of the target 7. The target 7 is mounted in the tube 1 so that the electrode 15 faces the electron gun 3. The second electrode 16 is formed by a transparent, conductive layer 26 on the reverse side of the glass foil 20. The electrode 26 is transparent and may consist of a thin layer of metal, for example, silver, applied by vaporisation, or of a layer of conductive metal oxide, for example, tin oxide. On the surface parts of the glass foil 20 not covered by the insulating strips 21, is provided in each mesh of the grid-shaped electrode 15 a separate, layer-element of a photo-conductive material, for example, photo-conductive lead monoxide, cadmium sulphide or antimony trisulphide, which layer-elements are in electrical contact with the adjacent parts of the conductors 25. The photo-conductive layer-elements 22, which may have a thickness of, for example, 5μ leave, at least partly, uncovered the top sides of these conductors, i.e. the sides facing the electron gun 3.

It may be advantageous to provide the photo-conductive layer-elements 22 with a very thin protective film, for example, of magnesium-oxide.

The free surfaces 23 of the layer-elements 22 assume, since the electrodes 15 and 16 are at different potentials (V_1 and V_2 respectively) a mean potential lying in between the former, owing to the series combination of, each time, a photo-conductive layer-element 22 and the subjoined part of the glass foil 20. This mean potential of a free surface 23 is dependent on the illumination of the relevant photoconductor layer-element 22, changes in the illumination result in changes in the resistivity of said photoconductive element. As the resistivity of the associated part of the glass foil 20 is constant, the mean surface potential of photoconductive layer-element 22 therefore follows the changes in the illumination of said particular element. A photoconductive layer-element 22 operates as a control-electrode for the electrons of the low velocity scanning beam 17 directed thereon in a sense such that in accordance with the higher or lower value of this mean surface potential a greater or smaller number of electrons of the scanning beam 17 are capable of attaining the adjacent conductors of the grid electrode 15 and conversely a smaller or a greater number of electrons are returned to the anode 6. Since the potential V_1 of the first electrode 15 is positive, for example, +10 v., and the potential V_2 of the second electrode 16 is larger and also negative, for example −40 v. (see the connections to the battery 14 of FIG. 1), the potential of the surface 23 of a photo-conductive layer-element 22 will be more positive for a lower resistance of this element, i.e. the greater is the local brightness of the optical image projected onto the control target 7. Therefore, the instantaneous electric current produced during scanning of the control target 7 by the electron beam 17, passing through the supply conductor to the electrode 15 and also through the supply conductor to the anode 6, is a measure of the illumination of the elementary part of the control target to which, at the said instant, the electron beam 17 is directed. Owing to the scanning movement of the electron beam the signal resistor 18 included in the supply conductor to the electrode 15 has produced across it voltage variations S1, which constitute electrical image signals corresponding to the image projected by the system 8 onto the target 7. Similar electrical image signals are obtained in the form of voltage variations S2 across a signal resistor 19, included in the anode supply conductor (FIG. 1). The latter image signals are complementary to the image signals S1 across the resistor 18. In order to minimize noise interference in the image signals, it is to be preferred to derive the image signals in a manner such that the signal current obtained by the control of the electron beam by a non-illuminated photoconductive element of the control target plate is at a minimum, which means that the electrical image signals corresponding to the parts of minimum brightness of the optical image projected onto the control target are the weakest. In the embodiment of the target 7 shown in FIG. 2, this is true for the signals S1 generated across the resistor 18 in the supply conductor to the electrode 15. Owing to the comparatively high capacitance between the electrode 15 and the planar electrode 16, the amplitude of the signals S1, particularly for the higher frequency, may be affected adversely. Owing to the lower capacitance of the anode 6 relative to the surroundings, this applies to a considerably smaller extent to the signals S2, but these signals have a less favourable signal to noise ratio. By using a target structure differing from that shown in FIG. 2, the last-mentioned disadvantage may be obviated. Examples of such a different structure are shown in FIGS. 3, 4 and 5.

The embodiment of the target shown in FIG. 3 comprises, similarly to the embodiment shown in FIG. 2, a foil 30 of conductive glass, which not only functions as a support, but also has an electric function. The first electrode 15 of the control target consists of spaced, parallel conductors 35, which are electrically connected to each other and which are applied directly to one side of the foil 30. The other side of foil 30 is provided with a layer of photo-conductive material 32, on which, opposite the interstices between the conductors 35 of the electrode 15 and parallel thereto are provided linear conductors 36, which are electrically connected to each other and which constitute, together, the second electrode 16 of the control target. The conductors 36 consist of substantially transparent conductive strips or lines, which may be made, for example, of metal applied by vaporisation. By voltage division the surface parts 33 of the glass foil 30 located between successive wires 35, obtain a potential varying with the local illumination or irradiation of the photo-conductive layer 32 and being lower the more intense the layer 32 is illuminated. A stronger illumination of the control target therefore results in the return of more electrons of the electron beam 17 to the anode 6, which is the reverse of what happens with a target as shown in FIG. 2. With an electron director as shown in FIG. 3 in the tube 1 of FIG. 1, it is the signals S2 across the resistor 19 in the supply conductor to the anode 6 which exhibit the most favourable signal to noise ratio.

The latter effect is also obtained with the use of a target with a cross section as shown in FIG. 4. This target comprises a glass foil 40, which constitutes mainly a support and need therefore not consist of conductive glass. On the side facing the electron gun 3, the foil 40 is provided with equidistant, parallel, conductive line- or strip-shaped electrodes 46, which are electrically connected to each other and which, together, constitute the second electrode of the electron director designated in FIG. 1 by 16. These electrodes 46 are transparent and consist, preferably, of conductive tin oxide applied to the foil 40. The interstices between the electrodes 46 are covered by paths 47 of an insulating, opaque material, for example, a black lacquer. These paths 47 and the electrodes 46 are covered by a photo-conductive layer 42, on which is provided the first electrode 15 of the target. This electrode consists of a plurality of electrically interconnected, parallel extending line-shaped electrodes 45, which are located centrally above the paths 47 in staggered relationship with the first electrode. These linear electrodes may be applied, for example, by a printing method or by vaporisation and may consist of a metal, for example, silver, or of graphite (obtained by applying a carbon suspension of the type "aquadag"). By illuminating the photo-conductive layer 42 through the foil 40, only those parts of the layer 42 have their resistance varied which are located above the transparent electrodes 46. In accordance with the intensity of the radiation falling through the electrodes 46 onto the photo-conductive layer 42, the potential of the surface parts 43 of this layer will be reduced (as in the preceding examples V_1 is a few volts positive and V_2 larger and also negative). As in the embodiment of FIG. 3, a stronger illumination of the control target results in an increase in the electron flow to the anode 6.

Instead of applying separate linear electrodes 46 to the foil 40, it is simpler to apply the electrode 16 in the form of an uninterrupted conductive layer to the foil 40, and to provide the paths 47 on this layer.

FIG. 5 shows a further embodiment of the target 7 in which the signal S2 exhibits a more favorable signal to noise ratio than the signal S1. The target of this embodiment corresponds for the most part with the target shown in FIG. 2. Corresponding parts are therefore designated by the same reference numerals. The important difference consists in that the target shown in FIG. 5 comprises an additional, i.e. a third electrode 50, which is constructed similarly to the electrode 15 consisting of the conductors 25. The conductors 51 of this third electrode 50 are arranged in spaced relationship over the conductors 25 and extend parallel thereto. They are supported by insulating material 52, for example, magnesium-oxide, which, at the same time, insulates electrically the conductors of the electrodes 15 from those of the electrode 50. If desired, the insulating material may also cover, in a very thin layer, the photo-conductive elements 22. In this embodiment the electrodes 15 and 16 of the target serve only for supplying the voltage to the voltage-dividing elements consisting of the photo-conductive layer-elements 22 and the underlying elements of the glass foil 20. In contradistinction to the target shown in FIG. 2, the potential V_1 of the first electrode 15 is adjusted to a negative value, whereas the potential V_2 of the second electrode 16 is a few volts positive. This means that the connections of the two electrodes as compared with those of the preceding embodiments are interchanged. In this case the electrode 50 operates as a collecting electrode for the electrons not returned to the anode 6 by the potential of the photo-conductive surfaces 22, which potential decreases with increasing illumination. To this end the electrode 50 is connected to a point of the battery 14, of which the potential V_3 is substantially equal to the positive potential V_2 of the second electrode 16. Advantageous values of V_1, V_2 and V_3 are, for example, —40 v., +10 v., +10 v.

Instead of providing the target of FIG. 5, as in the embodiment of FIG. 2, with a second electrode 16 in the form of an uninterrupted conductive layer, this electrode may take the form of parallel extending, electrically interconnected, conductive, line-shaped elements 56. These elements, which are to be transparent and may consist, for example, of conductive tin oxide, are applied opposite the interstices of the conductors 25 constituting the first electrode 15 and extending transverse to the plane of the drawing. The first electrode 15 may consist, in this case, only of these parallel conductors, which means that the transverse conductors comprised in the embodiment of FIG. 2 of the electrode 15 are omitted here.

FIG. 6 illustrates an electron tube according to the invention for converting an optical image into a luminescent image. The tube comprises a mainly cylindrical bulb 61, the left-hand end of which has an offset neck 62, in which an electron gun 63 with a cathode 64 is housed. Approximately in the centre of the tube, transversely to the longitudinal direction thereof, a control target 67 having openings 81 is provided, and by means of a diagrammatically shown optical system 66, an optical image can be projected thereon. The control target has a structure as shown in FIGS. 7 or 8 and comprises two electrodes 75 and 76, of which the former is at a low negative potential of, for example, —1 v. with respect to the cathode 64, whereas the second is at a more negative potential, for example, of —40 v. These potentials may be obtained by means of a battery 68. To the right-hand end wall of the tube 60 is applied a luminescent screen 69, which is provided on the side facing the control target 67 with a thin metal layer 70, serving as an electrode. The electrode 70 is connected to a high positive potential with respect to the cathode 64, for example, +10 kv., so that those electrons of a wide electron beam 71 emanating from the cathode 64, which pass through the openings 81 of the control target are accelerated towards the screen 69. A coil 65 surrounding the tube 60 focuses these electrons onto the said screen.

The control target 67 may have a structure as shown in FIG. 7. In this embodiment the electrode 75 consists of equidistant, parallel, metal conductors 72, which bear pair-wise on the edges of spaced, parallel strips 80 of conductive glass. The second electrode of the target 67 is formed by parallel conductors 76, which are applied to the other side of the strips 80 at the centre thereof. Between the conductors 72, on each of the strips 80 is provided a layer 73 of photo-conductive material, for example, lead monoxide or cadmium sulphide, which material engages laterally the conductors 72. The conductors 76 and that side of the strips 80 on which these conductors are arranged are provided with an opaque layer 77, for example, of black lacquer.

The potential of the free surface 74 of the photo-conductive layers 73 determines locally to what extent the electrons of the wide beam 71 will pass through the adjacent openings 81 or will be returned to be collected by the wall electrode **59**. This potential is dependent upon the local illumination of the photo-conductive layers **73** owing to the actual series combination of one element of a layer **73** with the subjacent part of a strip **80**. Owing to the control-effect of this potential more electrons will be allowed to pass accordingly as more light strikes the control target.

In the embodiment of the control target **67**, shown in FIG. 8, the electrode **76** is formed by metal wires **86**, provided with an envelope **90** of conductive glass. The thickness of the envelope is, for instance, 5 to 10μ. On each envelope, in the plane of the wires **86**, two parallel conductors, for example, wires **82** are arranged diametrically opposite each other, which wires constitute, together, the first electrode **75** of the target. The wires **82** and the envelope **90** are provided, on the side of the target facing the optical system **66**, i.e. the left-hand end surface of the tube **60**, with a layer **83** of photo-conductive material. The envelope **90** is preferably opaque, so that, as is obtained by means of the lacquer layer **77** in the embodiment of FIG. 6, light originating from the phosphor layer **69** and radiated towards the control target **67** is prevented from reacting upon the photo-conductive layers **83** and **73** respectively.

Also in this embodiment of the target the local potential at the surface of the photo-conductive paths **83** determines what part of the electrons of the wide beam **71** directed to the target is allowed to pass. Also in this case the series combination of the photo-conductive elements and the elements of constant resistance (the envelope **90**) causes this potential to increase accordingly as more light strikes the target, so that more electrons are allowed to pass. The optical image projected onto the target **67** of the structure shown in FIG. 7 or 8 is thereby converted by the tube of FIG. 6 into a positive image on the screen **69**. Furthermore, because of the high acceleration voltage of the electrode **70**, a distinct intensification can be obtained. By interchanging in the target the photo-conductive elements **73, 83** and the associated elements of constant resistance **80, 90**, respectively, image reversal is obtained. The phosphor screen now shows the negative of the image projected onto the target.

FIG. 9 shows diagrammatically part of an electron tube according to the invention, by means of which, as with the tube shown in FIG. 1, an optical image can be converted into electrical image signals. The tube **91**, shown partly, comprises a target **97**, which is structurally similar to the target shown in FIG. 7 or FIG. 8. An optical image projected by the system **92** onto this target, of which the photo-conductive elements are facing this system produces thereon a potential image, which determines locally what part of the electrons of an electron beam **93**, scanning the other side of the target, is allowed to pass. These passing electrons are collected by an annular collecting anode **94**, which is connected via a signal resistor **95** to a high positive potential.

In the description of the above embodiments of the invention there has always been mentioned an optical image by which the resistance of photo-conductive elements of the control target is varied to a greater or smaller extent. As a matter of course, this image need not be formed by visible light. Electro-magnetic radiation lying beyond the visible spectral region also may be used, provided the photo-conductive material of the target is sensitive thereto. Therefore, by using a suitable photo-conductive material an electron tube according to the invention may be rendered suitable for working, for example, infrared, ultraviolet or X-ray images. If the elements of variable resistance in the target are made of a material which exhibits so-called bombardment induced conductivity, i.e. exhibits an increase in conductivity owing to the impact of high velocity particles, the image to be converted by the target may be formed by corpuscular rays, for example, electrons. Materials exhibiting bombardment induced conductivity are, for example, zinc sulphide, magnesium oxide and silicon carbide.

When using such a material in the target of the electron tube according to the invention, the potential image on this target resulting in electrical output signals or the luminescent output image, may be obtained by means of an electron beam scanning this target and modulated by the image information or a wide electron beam directed thereon and having a local intensity corresponding to the image information. Such an electron ray or beam may emanate from an additional electron gun or a photo-cathode respectively, having a high negative potential relative to the target.

What is claimed is:

1. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a first electrode comprising a plurality of conductive portions spaced apart in a plane, a second electrode spaced from said first electrode, at least one of said electrodes having a surface exposed to said electron beam, and variable resistance means interposed between said electrodes and comprising a first component having a relatively fixed resistance value and a second component in series circuit relationship to said first component, said second component having a variable resistance value and comprising a photoconductive material at least a portion of which is aligned with the spaces between adjacent portions of said first electrode, said photo-conductive component undergoing localized changes in electrical conductivity upon impingement of electromagnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for supplying an operating voltage to said exposed electrode thereby to bias said electrode to prevent the passage of beam electrons, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

2. Apparatus as described in claim **1** wherein said electron beam source comprises a cathode operated at a given potential, said apparatus further comprising means for applying to said first electrode a first potential positive with respect to said cathode potential and to said second electrode a second potential negative with respect to said cathode potential.

3. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a first electrode comprising a plurality of portions spaced apart in a plane, a second electrode spaced from said first electrode, at least one of said electrodes having a surface exposed to said electron beam, and variable resistance means interposed between said electrodes and comprising a supporting layer comprising a material having a relatively fixed resistance value and a superposed layer of a material having a relatively variable resistance value connected in series circuit relationship to said first layer, said superposed layer comprising a photo-conductive material interposed between adjacent portions of said first electrode and undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

4. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer comprising a material having a finite relatively fixed resistance value, a first electrode in the form of a conductive grid arranged on one side of said supporting layer facing said electron beam, a second electrode arranged on the opposite side of said supporting layer, a photo-conductive material interposed between adjacent portions of said first and second electrodes, said photo-conductive material undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, a source of voltage connected to said first and second electrodes, said voltage applied to said first electrode being adapted to produce a bias on said first electrode sufficient to prevent the passage of a substantial number of said beam electrons past said first electrode, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

5. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer comprising a material having a finite relatively fixed resistance value, a first electrode in the form of a conductive grid disposed on one surface of said supporting layer facing said electron beam, a layer of a photo-conductive material on the opposite side of said supporting layer, a second electrode in the form of a conductive grid arranged on the surface of said photo-conductive layer, said photo-conductive material undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation and producing a charge pattern on the opposite surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

6. Apparatus as described in claim 5 wherein said first and second electrodes and said supporting layer and said photo-conductive layer form an electrical series circuit and wherein the elements comprising said first electrode conductive grid are arranged in substantially parallel alignment with the elements of said second electrode conductive grid, the elements of said second electrode conductive grid being located opposite the spaces between the elements of said first electrode conductive grid.

7. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer of insulating material, a first electrode in the form of a transparent conductive grid disposed on the surface of said layer, opaque insulating portions disposed on said surface between adjacent portions of said grid, a layer of a photo-conductive material disposed on said grid and opaque portions, a second electrode in the form of a conductive grid disposed on said photo-conductive layer and facing said electron beam, said second electrode being staggered relative to said first electrode, said photo-conductive layer undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

8. Apparatus as described in claim 7 wherein said supporting layer of insulating material is transparent to light and further comprising means for projecting an optical image on the free surface of said supporting layer, said opaque insulating portions serving to shield portions of said photo-conductive layer from impingement by the electro-magnetic radiation of said optical image.

9. Apparatus as described in claim 7 wherein said electron beam source includes an electron-emissive cathode having a given potential and further comprising means for applying a first potential slightly positive with respect to the cathode potential to said second electrode and a second potential negative with respect to the cathode potential to said first electrode, said first and second elecrodes coacting with said photo-conductive layer to produce said charge pattern on the surface of said target electrode upon impingement by electromagnetic radiation whereby the number of beam electrons landing on said second electrode grid is caused to vary with said charge pattern.

10. Apparatus as described in claim 7 wherein the elements comprising said second electrode conductive grid are mounted substantially parallel to the elements of said first electrode conductive grid, said elements of said second electrode conductive grid being centrally located between the elements of said first electrode over said opaque insulating portions.

11. Apparatus as described in claim 7 further comprising a layer of insulating material disposed on the free surface of said layer of photo-conductive material.

12. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a first electrode comprising a plurality of conductive portions each having a surface exposed to said electron beam and spaced apart in a plane, a second electrode spaced from said first electrode, and variable resistance means interposed between said electrodes and comprising a supporting layer of glass having a relatively fixed resistivity and a superposed layer of a material having a variable resistance value connected in series circuit relationship to said first layer, said superposed layer comprising a photo-conductive material interposed between adjacent portions of said first and second electrodes and undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for applying a voltage to said first and second electrodes whereby said first electrode is biased to act as a shield for preventing the passage of beam electrons, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

13. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer of glass having a resistivity of the order of 10^9 to 10^{12} ohm cm., a first electrode in the form of a conductive grid arranged on one side of said supporting layer facing said electron beam, a second electrode arranged on the opposite side of said glass layer, a superposed layer of photo-conductive material arranged on the surface of said supporting layer facing said electron beam, at least a portion of said material being aligned with the

interstices of the grid of said first electrode, a layer of insulating material disposed on said layer of photo-conductive material, said photo-conductive material undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

14. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer of glass having a resistivity of the order of 10^9 to 10^{12} ohm cm., a mesh of insulating material on one surface of said glass layer, a layer of photo-conductive material superimposed on said insulating mesh and in contact with said glass layer at portions thereof exposed through said mesh, a first electrode comprising a conductive mesh superimposed on said photo-conductive layer substantially in coincidence with said insulating mesh, a second electrode arranged on the opposite side of said glass layer, said photo-conductive material undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern over the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

15. Apparatus as described in claim 14 wherein said second electrode comprises a thin transparent sheet of conductive material deposited on the surface of said glass layer and making electrical contact therewith.

16. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer of glass having a resistivity of the order of 10^9 to 10^{12} ohm cm., a grid of insulating material on one surface of said glass layer, a layer of photo-conductive material superimposed on said insulating grid and in contact with said glass layer at portions thereof exposed through said grid, a first electrode in the form of a conductive grid superimposed on said photo-conductive layer substantially in coincidence with said insulating grid, a second insulating grid superimposed on said conductive grid, a second conductive grid superimposed on said second insulating grid, a second electrode in the form of a conducting grid arranged on the opposite side of said glass layer in staggered relationship to said first electrode, said photo-conductive material undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode and modify the intensity of said beam as determined by variations of the charge pattern on the surface of said target, and output signal means for producing an output signal as determined by the variations of the charge pattern.

17. Apparatus as described in claim 16 wherein said electron beam source includes a cathode and further comprising means for supplying said second conductive grid and said second electrode with operating potentials slightly positive with respect to said cathode and said first electrode conductive grid with a negative potential with respect to said cathode whereby said second conductive grid is caused to act as a collecting anode for a portion of said beam electrons.

18. An image signal generating tube system comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a first electrode comprising a plurality of conductive portions spaced apart in a plane, a second electrode spaced from said first electrode, at least one of said electrodes having a surface exposed to said electron beam, and variable resistance means interposed between said electrodes and comprising a first component having a relatively fixed resistance value and a second component in series circuit relationship to said first component, said second component having a variable resistance value and comprising a photo-conductive material interposed between adjacent portions of said first electrode, said photo-conductive component undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for supplying an operating voltage to the electrode exposed to said electron beam thereby to bias said exposed electrode to prevent the passage of beam electrons, means for scanning said beam over the surface of said target electrode thereby to produce current flow to said target electrode having variations as determined by variations of the charge pattern over the surface of said target, and impedance means connected to said first electrode for producing an output signal.

19. An image signal generating tube system comprising an electron gun assembly for producing an electron beam and including a cathode and an anode, a target electrode in spaced relationship to said gun assembly and arranged in the path of said beam, said target electrode comprising a first electrode comprising a plurality of conductive portions spaced apart in a plane, a second electrode spaced from said first electrode, at least one of said electrodes having a surface exposed to said electron beam, and variable resistance means interposed between said electrodes and comprising a first component having a relatively fixed resistance value and a second component in series circuit relationship to said first component, said second component having a variable resistance value and comprising a photo-conductive material interposed between adjacent portions of said first electrode, said photo-conductive component undergoing localized changes in electrical conductivity upon impingement of electro-magnetic radiation thereby to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to modify the intensity of the beam as determined by variations of the charge pattern over the surface of the target, field producing means for forming a focusing field within said tube to cause said electron beam to be returned towards said gun assembly and to land upon said anode, and impedance means connected to said anode for producing an output signal.

20. Apparatus as described in claim 10 wherein said anode is located between said cathode and said target and is supplied with an operating potential positive with respect to said cathode.

21. An image signal generating tube comprising a source of an electron beam, a target electrode in spaced relationship to said source and arranged in the path of said beam, said target electrode comprising a supporting layer comprising a transparent material having a low but finite relatively fixed conductivity, a grid of insulating material on one surface of said supporting layer, a first electrode in the form of a conductive grid having a surface exposed to said electron beam and superimposed over said insulating grid and in alignment therewith, a layer of photo-conductive material interposed between adjacent

portions of said first electrode grid and in contact therewith and with said supporting layer at portions thereof exposed through said insulating grid, a second electrode arranged on the opposite side of said supporting layer and in electrical contact therewith, means for supplying operating potentials to said first and second electrodes whereby said first electrode substantially shields the exposed surface of said photo-conductive layer from impingement by beam electrons, means for projecting an optical image onto said photo-conductive material to cause localized changes in electrical conductivity therein to produce a charge pattern on the surface of said target electrode facing said electron beam source, means for scanning said beam over the surface of said target electrode thereby to produce current variations to said target electrode whereby said electron beam is modulated in accordance with variations in the charge image pattern over the surface of said target, and means for deriving an output signal as determined by the modulation of said electron beam.

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