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TELEVISION PICKUP TUBE

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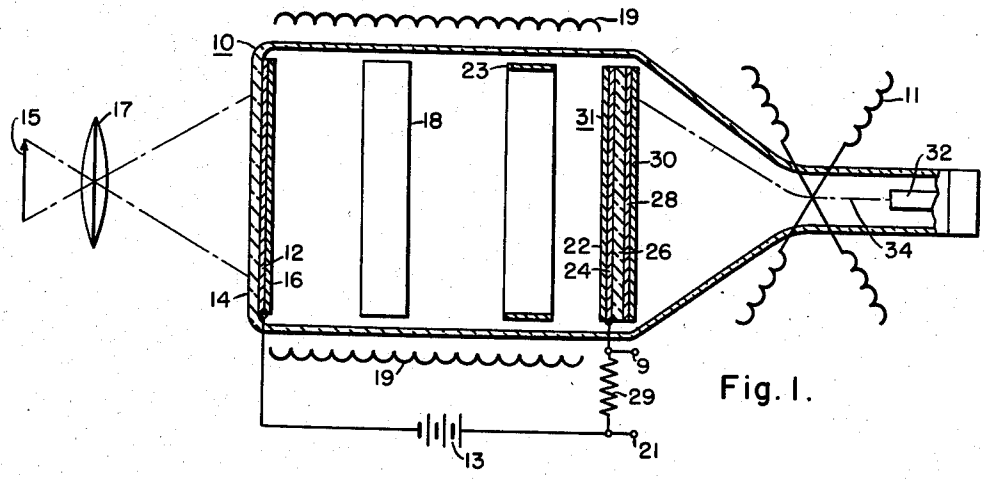


Fig. 1.

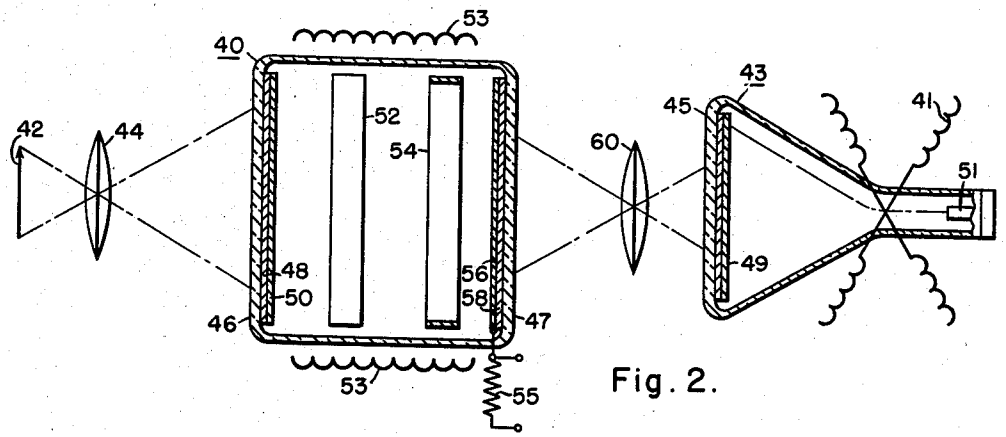


Fig. 2.

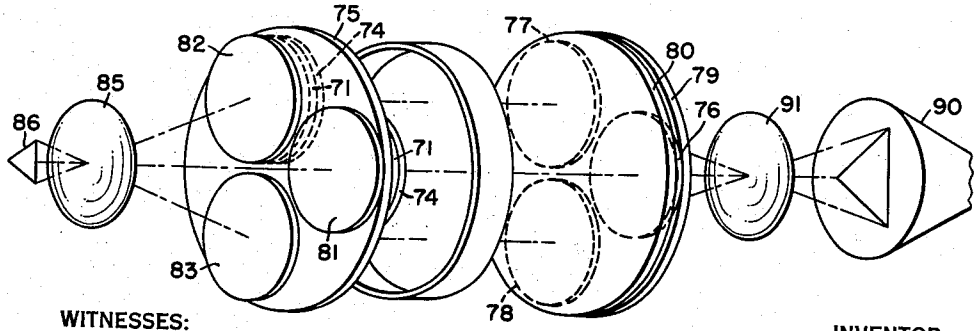


Fig. 3.

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TELEVISION PICKUP TUBE

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This invention relates to television transmitting systems and more particularly to television pickup tubes.

It is an object of my invention to provide an improved television pickup tube.

It is another object to provide a high sensitivity television pickup tube.

It is another object to provide a television pickup tube having a wide spectral response in the visible range.

It is another object to provide an improved television pickup tube suitable for color television.

These and other objects are affected by my invention as will be apparent from the following description taken in conjunction with the accompanying drawing, and in which:

Figure 1 is a schematic representation of a television pickup tube embodying my invention;

Fig. 2 is a schematic representation of a television pickup tube embodying another form of my invention; and

Fig. 3 is a perspective view of a color television pickup tube embodying my invention.

Referring in detail to Fig. 1, there is shown an evacuated envelope 10 having a transparent conductive coating 12, such as Nesa, deposited on the inside of the face plate 14 of the envelope 10. A photoelectric emissive film or photoemitter 16 is deposited on the conductive coating 12. It may be desirable in some applications of my invention and with a suitable photoemissive material to eliminate the conductive coating 12 which is placed on the face plate 14. The face plate 14 of the envelope 10 and the conductive coating 12 are of transparent material so that light may pass to the photoemitter 16 undistorted. Radiations from an object 15 are focussed on the photoemitter 16 by means of any suitable optical system represented schematically by the lens 17.

An electrode structure or target 31 is mounted within the envelope 10 parallel to and alined with the photoemitter 16. The target 31 includes a transparent conductive layer 24 and a layer or coating 22 of a material capable of becoming conductive upon light illumination such as a photoconductor. The photoconductive layer 22 is deposited on the surface of the layer 24 facing the photoemitter 16.

A fluorescent screen 30 comprised of a phosphor material capable of emission of light upon electron bombardment is placed within the envelope 10 parallel to and alined with the target 31 on the side of the target 31 remote from the photoemitter 16. A transparent conductive coating 28 is applied to the side of the fluorescent screen 30 facing the target 31 and is insulated from the conductive coating 24 by suitable means such as a transparent insulating layer 26.

At the opposite end of the envelope 10 from the face plate 14 an electron gun 32 of suitable design is positioned for generating, focussing and accelerating an electron beam 34 toward the fluorescent screen 30. The electron beam 34 is caused to scan a raster upon the fluorescent screen 30 by any suitable deflection means represented schematically by the coil arrangement 11. An

electromagnetic lens system of suitable type is provided on the exterior portion of the envelope 10 between the photocathode 16 and the target 31 for the focussing of the photoelectrons passing between the photoemitter 16 and the target 31. This lens system is represented by the coils 19.

An electron multiplier 18 may be provided between the photoemitter 16 and the target 31 for the purpose of amplification of the photoelectrons' image emitted from the photoemitter 16. The electron multiplier 18 is of suitable design and might take the form of a series of thin secondary emissive plates or dynodes. A suitable device is described in "Photoelectricity" by V. K. Zworykin and E. Ramberg, published by John Wiley and Sons, 1949, page 144. The increase in positive potential which may be applied between the photoemitter 16 and each of the succeeding secondary emitting dynodes permits an electron image to be formed which is many times the intensity of the initial electron image.

An electrode 23 may also be provided near the target 31 to provide a means for collecting secondary emission from the photoconducting layer 22 of the target 31. It may be desirable in some applications that the electrons emitted from the photocathode 16 strike the target 31 with an energy of the order of 100 electron volts so that a greater number of secondary electrons will be emitted from the photoconductor than there are incident electrons and as a result a positive charge will be built up on the photoconductor 22. The collector ring 23 removes the secondary electrons or else they would return to the photoconductor 22 and erase the positive charge. The collector ring 23 should be held to a positive potential of the order of 25 volts with respect to the photoconductor 22.

In the operation of the device shown in Fig. 1, the radiations emitted from the object 15 are focussed upon the face plate 14 of the envelope 10 by means of the lens 17 so that a light picture representative of the object falls upon the photoemitter 16. When the light strikes the photoemitter 16 electrons are emitted from the photoemitter 16 to form an electronic image representative of the object 15 being viewed. A suitable voltage source such as a battery 13 is placed between the photoemitter 16 and the target 31 so that the electrons emitted from the photoemitter 16 will move to the target 31. The spreading of the electrons as they pass between the photoemitter 16 and the target 31 is prevented by the coils 19 surrounding the envelope 10.

The electrons from the photoemitter 16 move at a relatively low energy of the order of 5 electron volts and will be attracted to the target 31 and a negative charge will be built up on the surface of the photoconductor 22 and form a charge picture of the object 15. The electron beam 34 emitted from the electron gun 32 is caused to scan a raster upon the fluorescent screen 30, causing the fluorescent screen 30, which is of short persistence, to emit a ray of light which in turn scans a light raster upon the photoconductor 22. The ray of light emitted from the fluorescent screen 30 passes through the conductors 28 and 24 and the insulating layer 26 to the photoconductor 22, causing an elemental area of the photoconductor to become conductive. This conductive elemental area of the photoconductor 22 permits the electron charge on the surface of this elemental area to pass through the photoconducting layer 22 to the conductive coating 24, allowing a current to pass through a resistor 29 from which an output may be taken across terminals 21 and 9. In this manner, point by point, the charge image on the photoconductor 22 is scanned.

A suitable photoconducting material for the layer 22 should have primarily a very low dark current conductivity to avoid loss of sensitivity and high background noise.

The photoconducting layer 22 should also have a rapid rise and decay time so that a portion of the signal from the previously scanned element will not contribute to the signal being scanned. Similarly the fluorescent screen 30 should have a rapid rise and decay time. The fluorescent screen 30 associated with the photoconducting layer 22 should have an emission which lies within the region of sensitivity of the photoconducting layer 22. Since it is possible to prepare fluorescent screens which fluoresce in any desired region of the visible spectrum, as well as those which fluoresce in the ultra violet or infrared, no special spectral sensitivity is required for the photoconductor 22; hence the choice of photoconducting materials is very broad. By way of example, if it is desired to make the photoconducting layer 22 immune to any visible light which may pass through layers 14, 12 and 16, the photoconducting layer 22 may be chosen such as to be sensitive only to ultraviolet light and not to visible light. The fluorescent layer 30 may then be chosen to fluoresce in the region of the ultraviolet corresponding to the sensitivity of the photoconductor. Similar results may be accomplished by making use of a photoemitting surface 16 that is opaque so as to prevent visible light from reaching the photoconductor, or the photoconducting surface 22 facing the photoemitter 16 may be coated with an opaque film so thin that the electrons can readily pass thru it by conduction but are effectively insulated from adjacent picture elements. This arrangement would permit the use of a phosphor in the fluorescent screen 30 emitting in the visible region.

The device described in Fig. 1 owes its high sensitivity primarily to the storage effect of the photoconductor 22 which permits the charge to accumulate over the one frame scan.

Referring in detail to Fig. 2, I have shown a tube incorporating my invention which permits the utilization of a scanning device which is separate and not integral with the viewing tube. An envelope 40 is provided having a conductive coating 48 provided on the inside of a face plate 46 at one end of the envelope 40 and a conductive layer 58 provided at the opposite end of the envelope 40 on face plate 47. A photoelectric emissive material or photoemitter 50 is deposited upon the conductive layer 48 while a photoconductive layer 56 is deposited upon the conductive coating 58.

As in the device shown in Fig. 1, an electron multiplier 52 and a collecting electrode 54 may be utilized in certain applications. On the input side of the envelope 40, facing the face plate 46, is provided a lens 44 similar to that described in Fig. 1 capable of focussing light radiations from an object 42. At the opposite end of the envelope 40, a lens 60 is provided for focussing a light ray upon the photoconductor 56. The light ray for scanning a raster on the photoconductor 56 is provided by the external cathode ray tube 43. The cathode ray tube 43 comprises an evacuated envelope 45 having a fluorescent screen 49 at one end thereof of a very short persistence phosphor and an electron gun 51 positioned at the opposite end of the envelope 45. A raster is scanned on the screen 49 of the cathode ray tube 43 by the electron gun 51 and a suitable deflection means 41 and an image of this light raster is projected upon the photoconductive surface 56 by means of the lens 60.

The operation of the detecting portion of the tube is similar to that described in Fig. 1 in that the scene or object 42 to be televised is projected onto the photoemitter 50 by means of a suitable lens system 44. The photoemitter 50 converts the optical image into an electron image which is focussed on the photoconducting surface 56 by means of a coil 53. The charge image accumulates on the surface of the photoconductive layer 56 until it is discharged, element by element, in orderly sequence as the image of the light raster of the cathode ray tube 43 scans the surface of the photoconductor 56. The signal appearing across the resistor 55 at any given

instant will be proportional to the charge accumulated on a particular elemental area of the photoconductive surface during the period petween two successive scans.

The unique features of the device is that the scanning portion is not an integral part of the tube. It is difficult in present systems of color television pickup to obtain registration of three rasters where scanning is accomplished by three electron guns which are held in registration by the use of electronic components. My invention permits the operation of registration by the simple means of an optical arrangement.

Referring in detail to Fig. 3, I have incorporated my invention into a color television pickup system capable of transmitting three primary colors. An evacuated envelope (not shown) is provided at one end with an end plate 75 with three insulated circular coatings 71, of a transparent conductive material such as Nesa upon the inner surface of the end plate 75 and three photoelectric emissive material layers or photo-emitters 74 deposited upon each of the conductive coatings 71. The opposite face 79 of the envelope is provided with three target electrodes insulated from each other and of similar dimensions as the circular coatings 71 on the opposite face plate 75 of the envelope. Each target electrode is comprised of one of the conductive coatings 76, 77 and 78 on the face plate 79 of the envelope and a photoconductive coating 80 upon each of these conductive coatings 76, 77 and 78. Three filters 81, 82 and 83 are positioned exterior to the envelope and adjacent to the end plate 75 one in front of each of the conducting surfaces 71. Each of the filters 81, 82 and 83 has a different spectral response, for example, red, blue and green. A lens system 85 is provided in front of the filters 81, 82 and 83 so that the object 86 may be focussed on each of the filters 81, 82 and 83 so that light representative of different colors will fall upon each of the conducting surfaces 71. The conducting surfaces 71 being of a transparent material allow the light to strike the photoemitters 74 converting the optical image into three electron images each representative of a particular color. The electron images emitted from the photoemitters 74 in response to the light radiation are focussed by magnetic means (not shown) so that three separate electron charge images will be accumulated upon the photoconductor 80 adjacent to the conductors 76, 77 and 78, each of which is representative of one of the selected primary colors. A separate output circuit is connected to each of the conductors 76, 77 and 78 so that a representative signal of the three selected component colors such as red, blue and green is available. A cathode ray tube 90 is provided similar to that shown in Fig. 2 for obtaining a light ray which is focussed by the optical system 91 upon each of the conductors 76, 77 and 78 which is transparent so that the charge images on the photoconductor 79 may be scanned simultaneously by the light ray obtained from the cathode ray tube 90. A description of a suitable optical arrangement may be found in Color Cinematography by A. Cornwall-Clyde, published by Chapman-Hall, London, 3rd edition, 1951, pages 509–566. In this manner three separate charge images representative of the three selected colors are scanned and three signals obtained each representative of a different selected color.

It is possible by selection of suitable material to combine coatings 71 into one continuous layer of a transparent conductive coating and also to utilize a continuous coating for the photoemitters 74.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. A tube comprising an evacuated envelope having therein a photo-electric emissive surface and a target

alined with and spaced from said photo-electric emissive surface, said target comprising a layer of an electrical insulator which has the property of becoming conductive when illuminated by light, an electrically conductive layer on the side of said electrical insulator remote from said photo-electric emissive surface, means for projecting a light image upon said photo-electric emissive surface to produce an electron image of said light image, means for focussing the electron image upon the electrical insulator of said target to produce a negative charge image of the electron image, means for scanning said electrical insulator layer of said target point by point by a light beam thereby removing said electron charge image through said electrical insulator to said conductive layer, and an output circuit associated with said conductive layer.

2. In combination, an evacuated envelope having therein a photoelectric emissive surface and a target alined with and spaced from said photoelectric emissive surface, said target comprising a layer of a photoconductive material which becomes conductive when illuminated by light, an electrically conductive coating on the side of said target remote from said photo-electric emissive surface, means for projecting a light image upon said photo-electric emissive surface to produce an electron image of said light image, means for focusing the electron image upon the photo-conductive layer of said target to produce a positive charge image of the electron image, an electron multiplier positioned between said photo-electric emissive surface and said target, a secondary electron collector positioned near to said photo-conductive surface, means for scanning said target point by point by a light beam thereby removing the charge image through said photo-conductive layer to said conductive coating, and an output means associated with said conductive coating.

3. A tube comprising an evacuated envelope having therein a photo-electric emissive surface and a target for said photo-electric emissive surface, said target comprising a layer of photo-conductive material which has the property of becoming conductive when illuminated by light quanta, an electrically conductive signal electrode on the remote side of said photo-conductive layer with respect to said photo-electric emissive surface, means for projecting a light image on said photo-electric emissive surface to produce an electron image representative of a selected component color of said light image, means to focus said electron image upon said photo-conductive layer of said target to produce a charge image of the electron image, means for scanning said photo-conductive layer point by point by a light beam thereby removing said electron charge image through said photo-conductive layer to said signal electrode, and output means associated with said signal electrode.

4. A system having a photo-electric emissive cathode, a target alined with said photo emissive cathode, said target comprising a layer of an electrical insulator which has the property of becoming conductive when illuminated by light quanta, an electrically conductive coating on said electrical insulator remote from said photo emissive cathode, means for projecting a light image upon said photo emissive cathode to produce an electron image from the photo emissive cathode representative of said light image, means for focusing the electron image upon said target so as to produce a charge image of the electron image, a cathode ray tube having a fluorescent screen, means for deflecting the electron beam of said cathode ray tube to scan a raster on said fluorescent screen, a second optical means for focusing said light raster from said cathode ray tube on said target so as to remove said electron charge image from said electrical insulator layer to said conductive coating and output means associated with said conductive coating.

5. A radiation image pickup tube comprising an evacuated envelope having therein a photoelectric emissive surface for generating an electron image corresponding to

an input radiation image directed thereon, a target member positioned within said envelope, said target comprising a layer of insulating material which has the property of becoming electrically conductive when illuminated by light quanta, means for accelerating and focussing the electron image from said photoelectric emissive surface onto said layer of insulating material to form a charge image thereon corresponding to said electron image, an electrically conductive coating on said layer of insulating material remote from said photoelectric emissive surface, a fluorescent screen adjacent said conductive coating to illuminate said layer of insulating material and means for scanning said fluorescent screen with an electron beam.

6. A pickup tube comprising an evacuated envelope having therein an input screen comprising a photocathode surface for generating an electron image corresponding to a light image projected thereon, a target structure positioned within said envelope, means for accelerating and focussing said electron image from said photocathode surface onto the surface of said target, said target comprising a layer of photoconductive material which has the property of becoming electrically conductive when illuminated with light, said photoconductive layer facing said photocathode surface, a fluorescent screen alined with and positioned on the side of said target remote from said photocathode surface to illuminate said layer of photoconductive material and an electron source for scanning a raster on said fluorescent screen.

7. A radiation image pick-up tube comprising an evacuated envelope having therein an input screen onto which said radiation is directed, said input screen comprising a photoemissive surface, a target alined with said photo emissive surface for collecting the electrons emitted therefrom, said target comprising a layer of photo conductive material and a conductive coating thereon remote from said photo emissive surface, an electron multiplier positioned within said envelope between said photo emissive surface and said target, and means for scanning said photo-conductive layer point by point by a light beam.

8. An electron camera tube comprising a target for electrons, said target comprising a substantially continuous layer of an electrical insulator which has the property of becoming a conductor when illuminated with light, a conductive coating on one side of said layer, means for forming and directing to said layer image modulated photoelectrons, and means for scanning the side of said target remote from said layer with a light beam.

9. An electron camera tube comprising an envelope and having an input screen at one end of said envelope for generating electrons corresponding to light radiations directed thereon, a target member positioned at the other end of said envelope for intercepting the electrons emitted from said photoemissive cathode, said target comprising a layer of photoconductive material facing said photoemissive cathode, a screen member positioned on the remote saide of said target member with respect to said photoemissive cathode to illuminate said layer of photoconductive material and means for scanning a raster on said screen with an electron beam, said screen being capable of emitting light only in the ultraviolet region upon electron bombardment, said photoconductive material being responsive only to light in the ultraviolet region.

10. An electron camera tube comprising an evacuated envelope having therein a photoemissive cathode for generating electrons in response to light radiations thereon, a photoconductive electrode parallel to and alined with said photoemissive cathode for intercepting the electrons emitted from said photoemissive cathode, means for developing a potential between said photoemissive cathode and said photoconductive electrode for accelerating the electrons from said photoemissive cathode to said photoconductive electrode, a light transparent electrically conductive coating on said photoconductive electrode on the side remote from said photoemissive cathode, means for producing a light beam raster on said photo-

conductive electrode, and output means associated with said conductive coating.

11. A pickup tube comprising an envelope having a photoemissive cathode for generating an electron image corresponding to light radiations of a first wavelength directed thereon, a target member positioned within said enevelope for intercepting the electrons from said cathode, said target comprising a layer of insulating material having a conductive coating on said layer of insulating material remote from said cathode, said layer of insulating material exhibiting the property of becoming electrically conductive when illuminated by light radiations of a different wavelength than said first wavelength and means for scanning the side of said target remote from said photoemissive cathode with a light beam of said different wavelength.

12. A color television pickup system comprising an evacuated envelope having therein a photoelectric emissive surface for each of the selected color components and a target member for each of said photoelectric emissive surfaces, said target members each comprising a layer of a photoconductive material which exhibits the property of electrical conductivity when illuminated by light quanta, an electrically conductive signal electrode on the remote side of said photoconductive layer with respect to said photoelectric emissive surface, means

for projecting a light image representative of the selected component colors upon each of said photoelectric emissive surfaces to produce electron images representative of the selected component colors of said light image, means to accelerate and focus the electron images from said emissive surfaces upon the respective photoconductive layers of said target members to produce a charge image thereon corresponding to each electron image, means for scanning said photoconductive layers in a point by point manner simultaneously by means of light thereby removing said electron image through said photoconductive layer to said signal electrode for deriving a signal representative of the select component colors.

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