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TELEVISION IMAGE AND PICKUP TUBE

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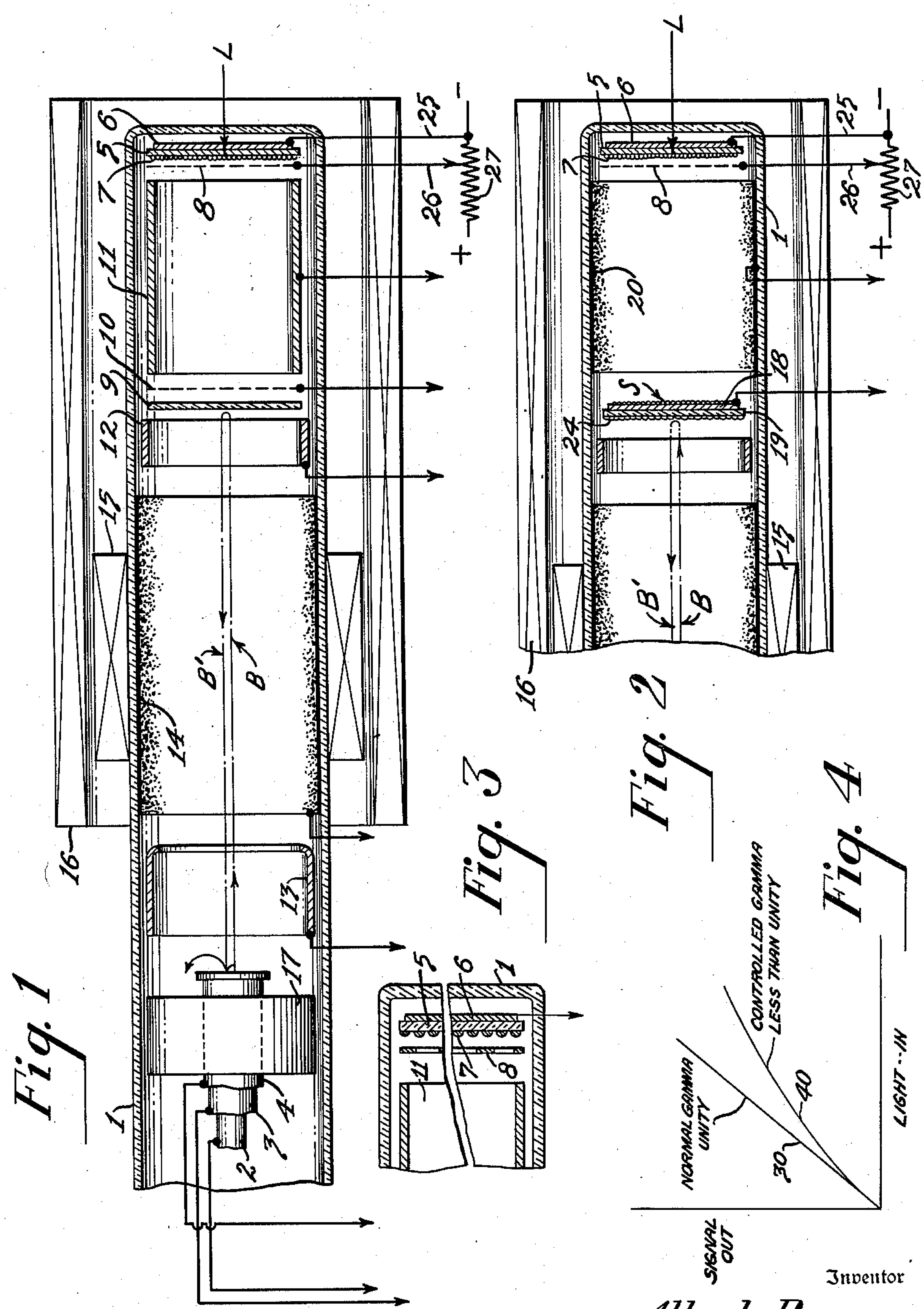


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**2,540,632**

## TELEVISION IMAGE AND PICKUP TUBE

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4 Claims. (Cl. 250—165)

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This invention relates to image tubes. The invention is not restricted to any particular type of tube, but it has particular importance in the orthicon type of cathode ray p ck-up tube in which the beam lands on the target at zero velocity or thereabouts. In this type of tube, with a limited signal output and a gamma of unity, the signals from the low lights may be in the noise range. One can bring the low light image charges above the noise by increasing the light over the entire photocathode, but this proportionately increases the high light charges on the target and the beam cannot fully discharge them.

It is an object of this invention to provide an arrangement for increasing the charges by the low lights without proportionately increasing those by the high lights.

Another object is to provide means for limiting the signal charges of the high lights without limiting those of the low lights.

Another object of the invention is to provide means for varying the gamma of a pick-up tube by a control potential.

Other objects of the invention will appear in the following description, reference being had to the drawings, in which:

Fig. 1 is an axial section of a pick-up tube embodying the invention; and

Fig. 2 is a modification.

Figure 3 is an enlarged view of a portion of the tube shown in Figure 1.

Figure 4 is a graphical showing of the relationship between the light input and signal output of pickup tubes to be described.

Referring to the drawing, the invention is shown as applied to an image orthicon tube, which is essentially the combination of an image tube with the usual orthicon in which the beam lands at low velocity on the target. In Fig. 1 the evacuated envelope 1 may consist of glass or other appropriate material. At one end of the tube is located the cathode 2 having the usual heater, not shown. The cathode is surrounded by a perforated grid 3 and a perforated first anode 4. All these parts may be of well-known construction. At the other end of the tube is located the image section, having a photocathode comprising a translucent semi-conducting film 5, a translucent conducting film electrode 6 and a photosensitive material 7 applied to the semiconductor 5. This photosensitive material shou'd not have sufficient conductivity to increase the conductivity of the semi-conducting element 5 along the surface facing the first anode, for reasons that will appear later. The parts 5, 6 and 7 are, of course, very thin elements and their thickness has been greatly exaggerated. In front of the photo-sensitive material 7 and closely adjacent thereto is located a fine mesh screen 8.

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In an intermediate part of the tube is located the target 9, which may consist of a thin semiconducting material, such as g'ass, fully described in my Patent 2,473,220 issued June 14, 1949, and my application filed November 28, 1945, Serial No. 631,441, now U. S. Patent No. 2,506,741, issued May 9, 1950. Reference to those applications is made for a full description of the target and its action, but it may be said briefly that the target of thin glass is sufficiently conducting for the electrons of the beam B landing thereon to pass through the target and discharge the image charge within a frame time, but the resistance is sufficiently high to prevent the image charges from spreading over the target within a frame time. Between the target 9 and the photocathode is located the fine mesh screen 10, usually called a signal screen, though I prefer to obtain the signal from the return beam B', as will later be referred to. Between the signal screen 10 and the photocathode is positioned the electrode 11 for accelerating the photo-electrons of the photocathode to the surface of target 9. Directly in front of the target 9 is positioned the decelerating ring electrode 12.

Immediately in front of the end of the first anode 4 is positioned an electrode 13, usually ca'led a persuader, and between the persuader electrode and the decelerating electrode 12 is located the usual wall coating anode 14. This electrode obviously need not be coated on the wall of the tube, as the name indicates. It may be a separate electrode mounted with the other electrodes, as disclosed in the patents of Stanley V. Forgue, 2,441,315 issued May 11, 1948, and 2,460,381 issued February 1, 1949, and the other electrodes disclosed herein may be supported within the tube in the way there disclosed.

To scan the beam B over the target, the usual deflecting unit 15 may be used. This may be cons'dered a collector for the photoemission from film 7 and may consist of two coils having their fields at right angles to each other and to the axial magnetic focusing field produced by coil 16. This coil is of sufficient length to provide an axial focusing field for the electrons of the beam B and the photoelectrons produced by the photocathode.

As I have stated, the signal could be taken off the conductor leading to screen 10, but it is preferable to multiply the signal before transmitting it to the pre-amplifiers (not shown). Various types of multipliers may be used, but I prefer to use the one disclosed in the Patent of Paul K. Weimer, 2,433,941 issued January 6. 1948. This multiplier is not described in detail herein and reference is made to the Weimer application for a full description, but it may be said that it consists of four or five multiplying stages surrounding the first anode. It is indicated herein by reference character 17.

The operation of my improved tube is as follows:

The imaging light L is focused on the photocathode. The rays pass through the translucent films 5 and 6 and cause emission of photoelectrons from the sensitive surface 7. These photo-electrons are accelerated by electrode 11 and bombard secondary electrons from the surface of collector target 9, which are collected by the screen 10. These photo-electrons are focused on the target by the axial field of coil 16. Thus, a charge pattern is produced on the surface of target 9 remote from the gun that produces a potential distribution corresponding to the distribution of light and shade of the image on the photocathode. As thus far described, the operation is the same as in the standard image orthicon.

My invention comprises the use of screen 8, connected by lead 26 to a voltage divider 27 and, to which I apply a voltage sufficiently near the potential of the low light charges on sensitive surface 7 to limit the high light charges, so that they cannot build up to the full potential that would normally be produced by the light. The potential of the high lights cannot increase above that of the screen, because in that case the surface would be more positive than the screen and the electrons would return to the sensitive surface and bring it back to the limiting potential of the screen. Thus I can vary the gamma of the tube by varying the potential on screen 8. Target electrode 6 is connected by lead 25 to a more negative portion of voltage divider 27 than screen 8.

The charge image produced on the photocathode side of target 9 is discharged by the electrons of the beam B landing thereon and passing through the thin glass film within a frame time. The remaining electrons of the beam then are accelerated back towards the end of the first anode 4 as beam B'. The end of the anode is the first dynode of the multiplier and the secondary electrons emitted are directed by the persuader electrode 13 to the remaining stages of the multiplier, indicated by block diagram 17, and the output of the tube is taken from the final stage of this multiplier by a conductor, not shown. It will thus be seen that, with my invention, I can increase the light L focused on the photocathode and thus bring the low light charges out of the noise range, while limiting the high light charges and keeping them sufficiently low to permit the beam to fully discharge them.

If the photocathode of the tube were of conventional type in which the photoemissive film 7 were in immediate contact with the conductive film 6, then those portions of the photosurface 7 illuminated by bright light would continue to emit a large part of the total photoemission without raising the potential of the surface 7, at those points, above the potential of the conductive surface 6. Under these conditions, the photoemission would be from the areas brightly illuminated by the scene. The presence of the positive grid 8 would have little or no effect on the photoemission from the target surface under these conditions.



Curve 30 of Figure 4 represents the relationship of the light input to photoemission from portions of a photosurface in direct contact with a signal plate. However, when a semiconducting film 5 is provided between the conductive plate 6 and the photoemissive surface 7, then the current flow, between conductive film 6 and those portions of the photosurface 7 illuminated by bright light, is greatly reduced and thus portions of the photosurface 7 which are illuminated by bright light will assume a charge equal to the product of the resistivity of film 5 and the current flow between film 6 and surface 7. The presence of the semiconducting film 5, in this manner, limits the current flow between films 6 and 7 to all portions of the photosurface 7, but in a much less degree to portions illuminated by low lights than those portions illuminated by bright or highlights of the scenes focused upon the photocathode electrode. Thus, more of the total current flow between films 6 and 7 will go to the portions of the photosurface illuminated by the low lights and will thus increase the signal response of the tube in the low light area. It is seen, then, that with a semiconducting film 5, the photoemission from each portion of the surface 7 is not in direct proportion to the light falling upon that surface. Curve 40 of Figure 4 represents the relationship between the light input and photoemission from portions of a photosurface having a semiconducting film between the photosurface and a source of energy.

Furthermore, the screen electrode 8 is very necessary when this semiconducting film 5 is used. If the screen 8 were not present, then those portions of the photoemissive film 7 illuminated by the high lights or bright portions of the scene would continue to charge up toward the potential of electrodes 10 and 11. In tubes of the type shown in Figure 1, the potential of electrodes 10 and 11 are in the hundreds of volts and long before the high light areas of surface 7 are charged to this potential, the potential of these high light areas would begin to distort the electron emission from the whole of surface 7. In this manner, then, it is necessary to provide a cut-off point beyond which the potential of the high-lighted portions of surface 7 cannot be charged. By providing the screen electrode 8 maintained at a positive potential of a few volts relative to that of film 6, the potential to which the high-lighted portions of surface 7 can be charged is limited to this potential, and as described.

It is desirable, in order to avoid picture distortion by large potential differences along the surface of the photocathode and in order to take advantage of the velocity distribution of the photo-electrons, to provide a smooth bending of the output versus input curve, to adjust the resistivity and thickness of the semi-conductor 5 for the range of light intensity employed, so that the screen 8 may be held at only a few volts positive with respect to the photo-sensitive surface 7. To provide this condition, the conductive film 6 and the screen 8 are connected to a voltage divider 27 by leads 25 and 26 respectively. As indicated in Figure 1, the source of potential 27 will provide the screen 8 with a potential positive by a few volts relative to that of conductive screen 6. If the maximum photo current in amperes to be passed by the screen is I, then the resistivity and thickness in centimeters of the semi-conductor 5 for a screen voltage of V is determined by the equation

$$I\frac{rd}{A}=V$$

where $r$ equals the resistivity of the semi-conductor in ohm centimeters, $d$ equals thickness of the semi-conductor in centimeters, A equals the area of the semi-conductor in centimeters squared.

My improvement may also be used as an image tube having an output of light with a desired relation (gamma) to the input and to project the light output onto the collector target of an orthicon, but in this case it is more efficient to combine the orthicon with the image tube, as shown in Fig. 2. In this modification, the potoelectrons emitted by the photocathode produce a light image by being focused on a fluorescent screen S coated on the translucent conductive film 18 on the back of a target plate 19 which may consist of a thin luminescent sheet of mica. A photosensitive mosaic 24 is formed on the opposite surface of the mica sheet 19 and is formed similar to surface 7 of the tube of Figure 1. The other elements shown in this figure are the same as those shown in Fig. 1 and they have been given the same reference characters. By way of variation, the accelerating anode has been shown as a coating on the inside of the tube at 20, instead of as a separate element 11, but the action is entirely the same.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What I claim as new is:

1. A photoelectric device comprising, a photocathode electrode including a photoemissive surface, an electrically conductive sheet parallel to and closely spaced from one side of said photoemissive surface and a material of high electrical resistance conductively connecting portions of said photoemissive surface respectively to adjacent portions of said conductive sheet, a collector electrode spaced from the other side of said photoemissive surface and a conductive screen electrode closely spaced from said other side of said photoemissive surface and between said surface and said collector electrode, means connected to said screen electrode and said conductive sheet for joining said sheet to a first source of potential and for joining said screen electrode to a second source of potential positive relative to said first source in the order of a few volts.

2. A photoelectric device comprising a semiconductive sheet, a photoemissive cathode film on one surface of said semiconductive sheet, and an electrically conductive film on the other surface of said semiconductive sheet, a collector electrode spaced from said one surface of said semiconductive sheet, a conductive screen electrode closely spaced from said one surface of said semiconductive sheet and between said sheet and said collector electrode, conductive leads connected respectively to said screen electrode and said conductive film for joining said conductive film to a first source of potential and for joining said screen electrode to a second source of potential positive relative to said first source in the order of a few volts, said semiconductive sheet having a high electrical resistance for limiting current flow between said photoemissive film and said conductive film.

3. An image pickup device comprising a photocathode electrode including a sheet of semiconductive material, a photoemissive film on one surface of said sheet, and a conductive film on the opposite surface of said sheet, said sheet being of high electrical resistance and conductively connecting said photoemissive film to said conductive film, a target electrode having an insulating surface and spaced from said photocathode, means between said photocathode and said target electrode for focussing the emission from said photoemissive film onto said target electrode to charge said insulating target surface, means including a scanning device for discharging said target surface and initiating a signal voltage therefrom, a screen electrode closely spaced from said photoemissive film and between said photocathode and said target electrode, and means for maintaining the potential of said screen electrode in the order of a few volts positive relative to the potential of said conductive film.

4. An image pickup device comprising a photocathode electrode including a sheet of semiconductive material, a photoemissive film on one surface of said sheet and a transparent conductive film on the opposite surface of said sheet, said semiconductive sheet being of high electrical resistance for conductively connecting said photoemissive film to said conductive film, a target electrode comprising a thin glass sheet spaced from said photocathode, electrode means between said photocathode and said target electrode for accelerating and focussing the emission from said photocathode onto said glass target to charge one surface thereof, an electron gun for providing a low velocity beam of electrons, electrode means for directing the electron beam to the opposite surface of said target for depositing electrons thereon and for returning the remaining electrons of the beam toward said gun, means for scanning the electron beam over said opposite surface of said glass target to discharge said target, and an electrode within said envelope for collecting the returning electrons of said beam, a conductive screen closely spaced from said photoemissive film and between said photocathode and said target electrode, and means connected to said conductive screen and said conductive film for joining said conductive film to a first source of potential and for joining said conductive screen to a second source of potential positive relative to said first source in the order of a few volts.

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## REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 2,172,726 | Bruche et al. | Sept. 12, 1939 |
| 2,244,365 | Iams | June 3, 1941 |
| 2,339,662 | Teal | Jan. 18, 1944 |