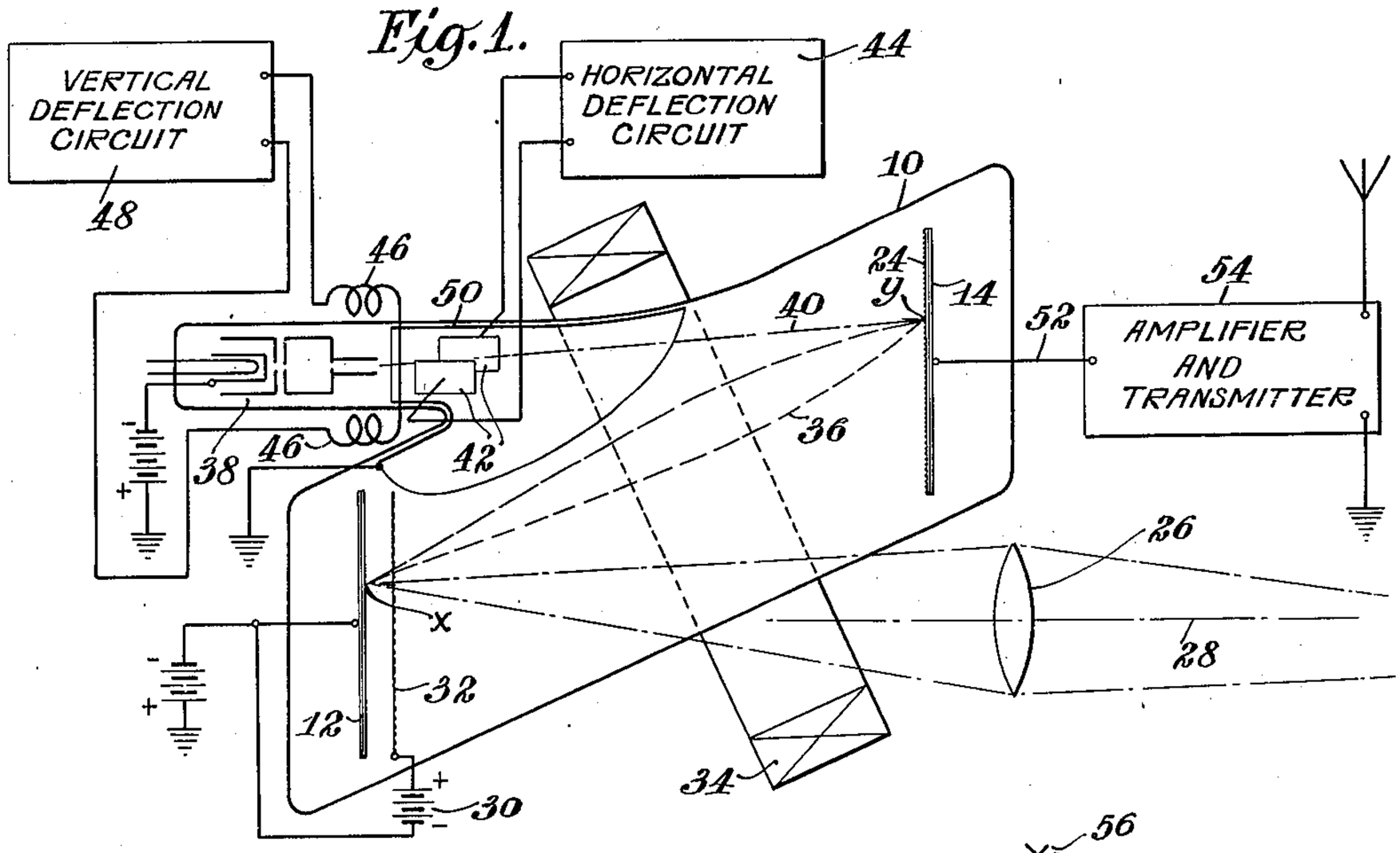
Oct. 14, 1941. A. V. BEDFORD 2,258,728

TELEVISION TRANSMITTING DEVICE

Filed Sept. 29, 1934

Fig. 1.



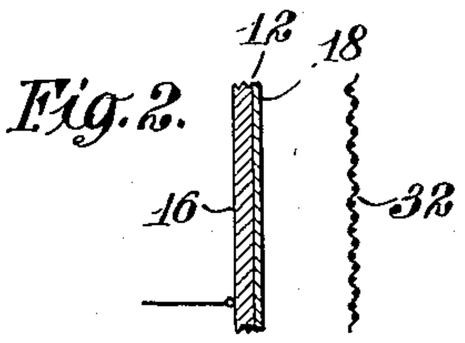


Fig. 2.

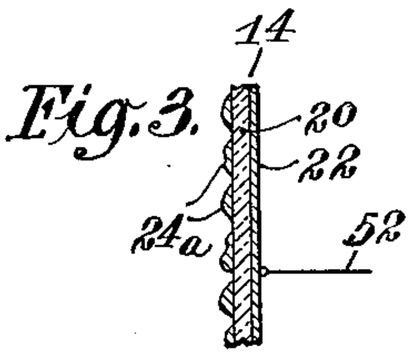


Fig. 3.

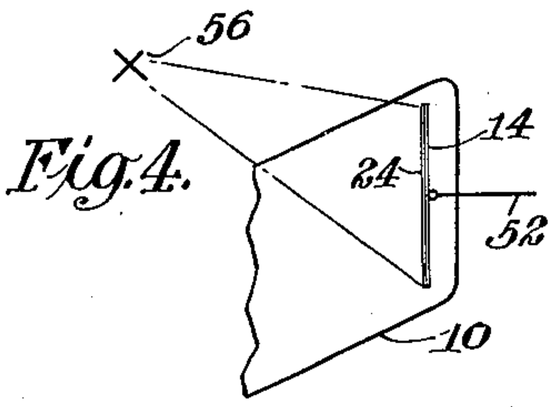


Fig. 4.

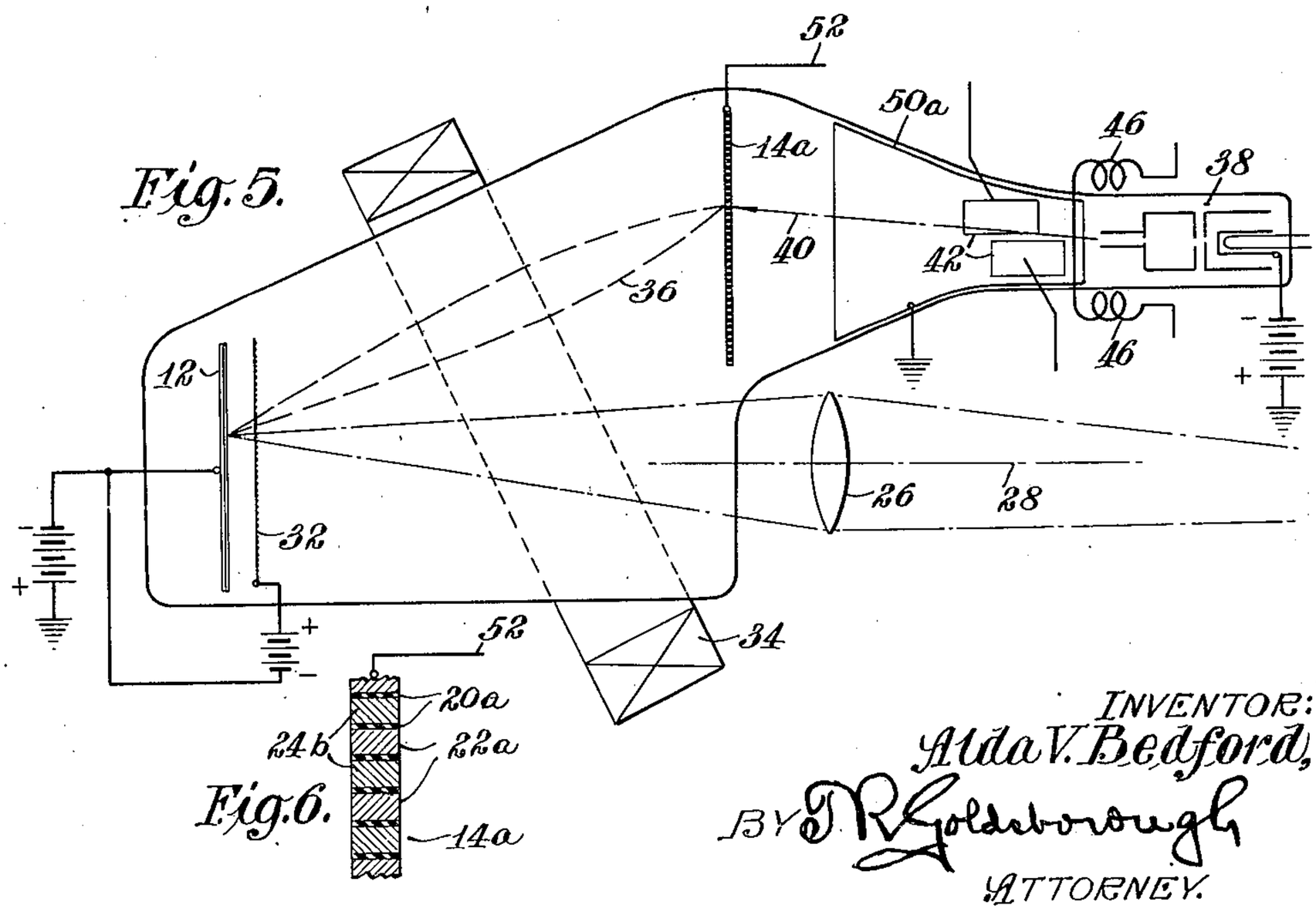


Fig. 5.

Fig. 6.

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TELEVISION TRANSMITTING DEVICE

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Application September 29, 1934, Serial No. 746,094

23 Claims. (Cl. 178—7.2)

My invention relates to improvements in television transmitting devices.

In the development of picture signals for television transmission, a cathode ray tube has been used for scanning. One type of such a tube is provided at one end thereof with a mosaic, photosensitive screen, and at its other end with a gun for developing a ray of electrons and directing the ray at the screen. The ray is focused on the screen and is deflected horizontally and vertically simultaneously to scan the photosensitive surface of the screen upon which an optical image of the object or subject for transmission is projected.

An important characteristic of operation in the transmitting tube of the type referred to resides in the fact that from the operating surface of the screen there occurs both the emission of photo-electrons due to light from the object and the emission of secondary electrons due to bombardment of this surface by the high velocity electrons in the scanning ray. The efficiency of these tubes is not as high as it is believed possible. This is due, it seems, to the fact that the photo-sensitivity, or action of the photo-electrons leaving the operating surface, is interfered with by the secondary emission, or action of electrons leaving the operating surface due to bombardment thereof by the electrons of the scanning ray.

Furthermore, in these tubes, difficulties are encountered in making the screen which is comprised of a sheet of insulating material, such as mica, provided on one side thereof with a coating of silver, and on its other side with a large number of minute silver globules or elements each insulated from the others and each photosensitized. While these screens have been made without particular difficulty up to the point where the insulating sheet has been provided with the silver coating on one side and the minute silver globules on the other side, difficulty has been experienced when the next step of photosensitization is carried out. That is, there has been the difficulty of obtaining uniformity of photosensitization over the surface, and of preventing at least some degree of leakage between adjacent elements of the mosaic surface due to deposition of photosensitive material in the almost microscopic spaces between the adjacent silver globules.

Furthermore, in the tubes referred to above, the degree of photosensitivity obtainable is limited due to the fact that it has not been feasible to apply a polarizing potential to the screen for the purpose of increasing the photo-emission.

With the foregoing in mind, it is one of the objects of my invention to provide an improved television transmitting device of the character referred to in which the action of emission of photo-electrons is independent of the action of emission of secondary electrons, and in which it is possible to apply a polarizing potential to the photo-sensitive surface to obtain a degree of photo-electric sensitivity substantially greater than has been possible under the same conditions with the various transmitting tubes proposed heretofore.

Other objects and advantages will hereinafter appear.

In accordance with my invention, I provide a tube at one end thereof with a screen having a continuous layer of photo-sensitive material upon which an optical image of the object is projected. The tube is provided at its other end with a screen having over a surface thereof a mosaic comprised of a great number of minute metallic elements each insulated from the others. In operation, photo-electrons leave the surface of the first screen under the influence of light from the object and also under the influence of a polarizing potential applied to an adjacent grid. In this way, the photo-electrons leaving any particular elemental area of the first screen are, under the influence of a focusing field, caused to travel to the second screen and to cause storage on the corresponding elemental area thereof of an electrostatic charge which is neutralized by the cathode ray during the scanning action, to develop the picture signals.

My invention resides in the improved construction and method of operation of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

Figure 1 is a diagrammatic view of a television transmitting system embodying a transmitting device constructed and operating in accordance with my invention to develop picture signals;

Figs. 2 and 3 are detail, fragmentary, sectional views, taken from Fig. 1;

Fig. 4 is a diagrammatic, fragmentary view, illustrative of a modification of the device in Fig. 1;

Fig. 5 is a view similar to Fig. 1, showing a modification; and

Fig. 6 is a detail, fragmentary, sectional view, taken from Fig. 5.

With reference to Fig. 1, 10 designates a tube provided at one end thereof with a screen 12 and at its other end with a screen 14.

The screen 12 comprises an imperforate metal plate 16 provided on a surface thereof with a substantially continuous layer 18 of photosensitive material such as caesium.

The screen 14 comprises a sheet 20 of mica or other insulating material provided on one side thereof with a coating 22 of metal such as silver, and on its other side with a mosaic surface 24 comprised of a great number of minute metallic globules or elements 24*a*. These elements are practically microscopic in size, and are spaced from and insulated from each other by the mica.

As shown in the drawing, the screens 12 and 14 are disposed so that the photosensitive surface 18 and the mosaic surface 24 face each other.

In operation, an optical image of the object or subject for transmission is projected onto the photosensitive surface 18 by a lens or optical system 26 disposed with its axis 28 perpendicular to the surface 18. In this way, photo-electrons are caused to leave the surface 18, the degree of photo-emission from any particular elemental area, such as *x*, for example, being proportional to the light intensity at the time on the corresponding elemental area of the object.

The degree of photo-emission from any particular elemental area for a given degree of light intensity on such area is increased substantially by a polarizing voltage applied from a source 30 to a grid 32 disposed adjacent to and in a plane parallel to the photo-sensitive surface 18. The grid 32 may be in the form of a screen of fine wire mesh or a metal ring.

With the grid 32 at a potential substantially more positive than the potential on the screen 12, photo-electrons leave the surface 18 freely, and travel to the screen 14 in the form of individual rays. Each ray is focused on the mosaic surface 24 by a magnetic field developed by a coil 34 disposed about the tube 10. The electrons, upon striking the screen 14, cause an electrostatic charge to be developed at the corresponding elemental area *y*, for example, the value of this charge corresponding to the degree of photo-electric emission from the corresponding elemental area *x* of the photosensitive surface 18.

Since there is photo-electric emission from each of the elemental areas over the surface 18, the degree of such emission from any particular elemental area corresponding to the degree of light intensity to which it is exposed, it can be said that when an optical image of the object is projected onto the screen 12 a current image is developed and, under the focusing action of the coil 34, is utilized to develop an electrostatic image over the operating surface 24 of the screen 14.

The picture signals are developed by neutralizing successively the individual electrostatic charges bound on the screen 14, for which purpose the tube 10 is provided with an electron gun 38 for developing a ray 40 of electrons and directing the ray at the screen 14. The ray 40 is deflected horizontally by plates 42 across which a saw-tooth voltage wave is applied from a suitable circuit 44, and is simultaneously deflected vertically by coils 46 through which a saw-tooth current wave, supplied from a suitable circuit 48, is caused to pass. An anode 50, in the form of a silver coating on the inside surface of the tube, and which is at a potential substantially more positive than the potential on the various elements comprising the gun 38, operates to focus the electron ray on the mosaic surface 24 of the screen 14 and to accelerate the electrons toward this screen.

As the ray 40 scans the screen 14, at each elemental area of the surface 24 the electrostatic charge previously bound at this point is neutralized, and electrons of secondary emission are emitted from this point and permitted to pass to ground by way of the anode 50.

During the scanning action the difference between the degrees of secondary emission from any two elemental areas correspond to the difference between the respective electrostatic charges previously stored at these two elemental areas. Picture signals are developed in a connection 52, leading to a suitable amplifier and transmitter 54 from the metallic coating 22 which constitutes, with each of the metal elements 24*a* on the opposite surface of the mica sheet 20, a minute condenser.

The tube itself is under a high vacuum, and the wall thereof is transparent to permit the entrance of light to the screen 12.

As represented in the drawing, the screen 12 is maintained at a relatively high negative potential with respect to ground.

From the foregoing it will be seen that I have provided an improved construction of television transmitting device embodying a mosaic screen, and in which the emission of photo-electrons takes place separately and independently from the emission of secondary electrons incident to scanning action by the cathode ray. On account of the novel combination and arrangement in my improved construction, it is feasible to employ means such as the grid 32 for the purpose of applying a relatively high polarizing potential to the screen from which photo-electric emission takes place. Furthermore, in my improved construction, it is not required that the mosaic surface 24 be photosensitized for the reasen that the satisfactory development of picture signals does not depend necessarily upon any action of photo-electric emission from this surface. In this way, the requirement for photosensitization of the mosaic surface, with the accompanying possibility of occurring leakage paths between the adjacent minute particles of the mosaic, is avoided.

If it occurs that, in a particular construction embodying my invention, an excessive and undesirable amount of electrons from the screen 12 reach the screen 14, it is proposed to remove these by making the individual elements 24*a* of the mosaic surface 24 photosensitive, and project onto this surface a steady, uniform light from a source represented at 56 in Fig. 4.

In the modification shown in Fig. 5, the electron gun 38 is disposed on the side of the screen 14 opposite that to which the photosensitive surface 18 of the screen 12 is directed. In this construction, the screen 14*a*, corresponding to the screen 14 in Fig. 1, is comprised of a metallic plate 22*a*, corresponding to the metallic coating 22 in Fig. 3, and provided with a large number of minute apertures in which are disposed metallic elements or inserts 24*b*, corresponding to the elements 24*a* in Fig. 3. Each of the elements 24*b* is insulated from the plate 22*a* by an insulating sleeve or coating 20*a* corresponding to and serving the same purpose as the mica sheet 20 in

Fig. 3, whereby the plate 22*a* forms, with each of the elements 24*b*, a minute condenser.

In operation, the photo-electric emission from the screen 12 causes development of individual electrostatic charges on the screen 14*a*. These charges are neutralized successively as the cathode ray 40 scans the right-hand surface of the screen. Electrons of secondary emission are emitted from this surface and pass to ground by way of the second anode 50*a* corresponding to and serving the same purpose as the anode 50 in Fig. 1.

The construction and operating action in Fig. 5 is otherwise the same as in Fig. 1.

It will be understood that various modifications, within the conception of those skilled in the art, are possible without departing from the spirit of my invention or the scope of the claims.

I claim as my invention.

1. A television transmitting device comprising a tube, an imperforate screen disposed within said tube and provided with a continuous photosensitive surface, a second screen disposed within said tube and provided with a mosaic surface, means for projecting onto said continuous photosensitive surface an optical image of the subject for transmission whereby photo-electrons are caused to be emitted from said surface, means for causing the electrons emitted to travel toward and to become focused upon said mosaic surface, means within the tube for developing a ray of electrons and directing the same at said second screen, and means for deflecting said ray to cause the same to scan said second screen.

2. A television transmitting device comprising a tube, an imperforate screen disposed within said tube and provided with a substantially continuous photosensitive surface, a second screen disposed within said tube and provided with a mosaic surface comprised of individual elements insulated from each other, means for projecting onto said photosensitive surface an optical image of the subject for transmission whereby photo-electrons are caused to be emitted from said surface, means for causing the emitted electrons to travel toward said mosaic surface, means for focusing the photo-electrons issuing from said photosensitive surface with respect to said mosaic surface, means within the tube for developing a ray of electrons and means directing the same at said second screen, and means for deflecting said ray to cause the same to scan said second screen.

3. A television transmitting device comprising a tube, a first screen disposed within said tube and provided with a photosensitive surface, a second screen disposed within said tube and arranged to receive photo-electrons issuing from said surface, an accelerative electrode disposed within said tube in proximity to said surface and capable of holding a potential substantially more psitive than the potential of said first screen, means for projecting onto said photosensitive surface an optical image of the subject for transmission to cause emission of photo-electrons from said surface, an electron lens means for focusing the electrons released from the first sceen upon the second screen means within the tube for developing a ray of electrons and means for directing the same at said second screen, and means for deflecting said ray to cause the same to scan said second screen.

4. A television transmitting device comprising a tube, a first screen disposed within said tube and provided with a photosensitive surface, a second screen disposed within said tube and provided with a mosaic surface facing and substantially parallel to said photosensitive surface, an optical system for projecting onto said photosensitive surface an optical image of the subject for transmission whereby photo-electrons are caused to be emitted from said surface, means for causing the photoelectrons to travel to said mosaic surface, means for developing an electrical field to focus the photo-electrons on said mosaic surface, means within said tube for developing a ray of electrons and means for directing the produced ray at said mosaic surface, and means for deflecting said ray to cause the same to scan said mosaic surface.

5. A television transmitting device comprising a tube, a first screen disposed within said tube and provided with a photosensitive surface, means within said tube for developing a ray of electrons, a second screen disposed within said tube between said means and said first screen, said second screen being provided with a mosaic of individual elements, means for projecting onto said photosensitive surface an optical image of the subject for transmission whereby photo-electrons are caused to be emitted from said surface, means for causing the photo-electrons to travel to said second screen to develop individual electrostatic charges upon the isolated elements comprising the mosaic, an electron lens means for focusing the electrons released from the first screen by light impinging thereon to spatially related areas of the mosaic and means for deflecting said ray to cause the same to scan said second screen.

6. A method of transmitting television signals which comprises producing an electronic current image of a subject, focussing the electrons of the current image upon a mosaic electrode surface to develop thereupon an electrostatic replica of the current image, and scanning the electrostatic replica to produce signals representative of the subject initiating the current image.

7. The method of producing television signals which comprises producing an electronic current image of a subject, accelerating the electrons of the current image in the direction of a mosaic electrode, focussing the accelerated electrons forming the current image upon the mosaic electrode to develop thereupon an electrostatic replica of the current image, producing a cathode ray scanning beam, and scanning the mosaic electrode with the produced cathode ray beam.

8. A television transmitting tube comprising an envelope, a continuous photo-electric surface positioned within the tube envelope and adapted to release electrons under the influence of light, a mosaic photo-electric surface also positioned within the envelope and supported to receive the electrons released from the continuous photo-electric surface, and means for developing an electron beam adapted to scan the mosaic surface upon which the electrons from the continuous photo-electric surface impinge.

9. A television system comprising an electron tube having in one end thereof a mosaic electrode, a continuous photo-electric electrode and an electron gun positioned in the opposite end of the tube and each adapted to direct electrons toward the mosaic electrode, means for illuminating the continuous photo-electric surface to cause electrons therefrom to be released toward the mosaic electrode, and means for causing the electrons from the cathode ray beam developed from the electron gun to sweep the mosaic electrode for scanning and producing signals.

10. In a picture transmitting device, a photoelectric plate, means for forming an optical image thereon to form an electron image of the object, an anode for attracting the electrons forming the image, an electron lens for focusing the electron image in a plane spaced from the photoelectric plate, a member in said plane composed of a conductor entirely covered with insulating material and having an electron storage member on said insulating material which stores the elements of the electron image, an electron gun for developing an electron beam, means for causing the electron beam to scan said storage member, and a signal circuit attached to said conductor, said signalling circuit being actuated by charges induced on said conductor by the charge on said storage member.

11. In a television transmitter, a photoelectric plate, means for casting an optical image thereon to form an electron image of the object, an electron image storage means, means for causing the electrons from the photoelectric plate to move towards the storage means, an electron lens for forming an electron image of the optical image on the storage means, an electron gun and means for causing the cathode ray beam from the electron gun to scan the storage means to remove the electron image therefrom and to successively develop electric signals proportional to the tone value of successive points on the optical image.

12. In apparatus for transmitting images which comprises a photo-electrically active screen upon which a light image is adapted to be directed to release photo-electrons and a mosaic electrode formed from a multiplicity of mutually insulated elements adapted to be scanned for transmission by a cathode ray beam, the method which comprises the steps of projecting an optical image upon the photo-electric screen to release photo-electrons, accelerating the released photo-electrons toward the mosaic electrode, focussing the accelerated electrons in their path toward the mosaic electrode, traversing the mosaic electrode with the cathode ray beam, and releasing electrical signaling impulses in accordance with the intensity of the initially released photo-electron flow.

13. A scanning device comprising a mosaic electrode of elemental condensers, a photoelectric cathode, an electron lens intermediate the mosaic and photoelectric cathode, a thermionic source of electrons, and an electron ray focusing system intermediate the thermionic source of electrons and the mosaic.

14. A scanning device comprising a mosaic electrode of elemental condensers, a photoelectric cathode, an electron lens intermediate the mosaic and photoelectric cathode, a thermionic source of electrons, an electron ray focusing system intermediate the thermionic source of electrons and the mosaic, and an electron ray deflecting system symmetrically disposed about the focusing system.

15. An electron discharge tube comprising a photoelectric cathode, a mosaic electrode of elemental condenser elements having secondary electron emissive properties, means to project electrons released from the photo-electric cathode upon the mosaic, an electron lens means to focus the photo electron stream upon the mosaic, means for scanning the mosaic element by element by a focused beam of electrons, and means to collect secondary electrons ejected from the elemental condenser elements produced by the impact of the projected focused beam of electrons.

16. An electron discharge device, comprising a mosaic electrode of elemental condenser elements having secondary electron emissive properties, photo-electric means for projecting an electron image upon the mosaic electrode, an electron lens means to focus the projected electron image upon the mosaic electrode, means to scan the mosaic element by element by a focused beam of electrons whereby secondary electrons are ejected in accordance with the elemental density of the electron image, and means to collect the emitted secondary electrons.

17. In the method of transmitting images of an object to a distance wherein there is provided a photoelectrically active screen and a mosaic screen formed of a plurality of mutually insulated elements, the steps of projecting an optical image of said object upon the photoelectrically active screen to generate photoelectrons therefrom, accelerating the generated photoelectrons toward the mosaic screen, focusing the accelerated photoelectrons upon the mosaic screen, regulating the velocity of the photoelectrons to emit from the mosaic screen secondary electrons less in number than the incident photoelectrons whereby each element acquires a negative charge, scanning the mosaic screen with a primary beam of electrons to bring the potential of each element in turn to a more positive value substantially the same for each element, and transmitting signals derived from the changes of potentials of said elements.

18. The method according to claim 17 comprising in addition the step of projecting the beam of primary electrons upon the side of the mosaic screen facing the photoelectrically active screen.

19. The method according to claim 17 comprising in addition the step of projecting the beam of primary electrons upon the side of the mosaic screen facing away from the photo-electrically active screen.

20. In the method of transmitting images of an object to a distance wherein is provided a transparent photoelectrically active screen and a mosaic screen formed of a plurality of mutually insulated elements, the steps of projecting an optical image of the object upon one side of the transparent screen, accelerating photoelectrons emitted from the other side of the screen toward the mosaic, focusing the emitted photoelectrons upon the mosaic screen, regulating the velocity of the photoelectrons to emit from the mosaic screen secondary electrons less in number than the incident photoelectrons, whereby each element acquires a negative charge, scanning the mosaic screen with a primary beam of electrons to bring the potential of each of the elements of the mosaic screen sequentially to a more positive value substantially the same for each element and transmitting signals derived from the changes of potential of said elements.

21. An electro-optical transmitting system comprising a photoelectrically active screen, a mosaic comprising a plurality of mutually insulated elements, means for projecting an optical image of said object upon the photoelectrically active screen to generate photoelectrons therefrom, means for accelerating the generated electrons toward the mosaic screen, means for focusing the accelerated photo-electrons upon the mosaic screen, means for regulating the velocity of the photoelectrons to emit from the mosaic

screen secondary electrons less in number than the incident photoelectrons whereby each element acquires a negative charge, means for scanning the mosaic screen with a primary beam of electrons to bring the potential of each element in turn to a more positive value substantially the same for each element, and means for transmitting signals derived from the changes of potentials of said elements.

22. An electro-optical transmitting system comprising a photoelectrically active screen, a mosaic comprising a plurality of mutually insulated elements, means for projecting an optical image of the object upon one side of the transparent screen, means for accelerating photoelectrons emitted from the other side of the screen toward the mosaic, means for focusing the emitted photoelectrons upon the mosaic screen, means for regulating the velocity of the photoelectrons to emit from the mosaic screen secondary electrons less in number than the incident photoelectrons, whereby each element acquires a negative charge, means for scanning the mosaic screen with a primary beam of electrons to bring the potential of each of the elements of the mosaic screen sequentially to a more positive value substantially the same for each element, and means for transmitting signals derived from the changes of potential of said elements.

23. In a television transmitter a cathode ray tube including a photosensitive screen at one end, a second screen of imperforate insulating material spaced from said first screen, means intermediate said screens for causing electrons emitted from said photosensitive screen to travel to said second screen and means including a cathode ray gun structure for scanning said second screen with an electron beam to develop picture signals.

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