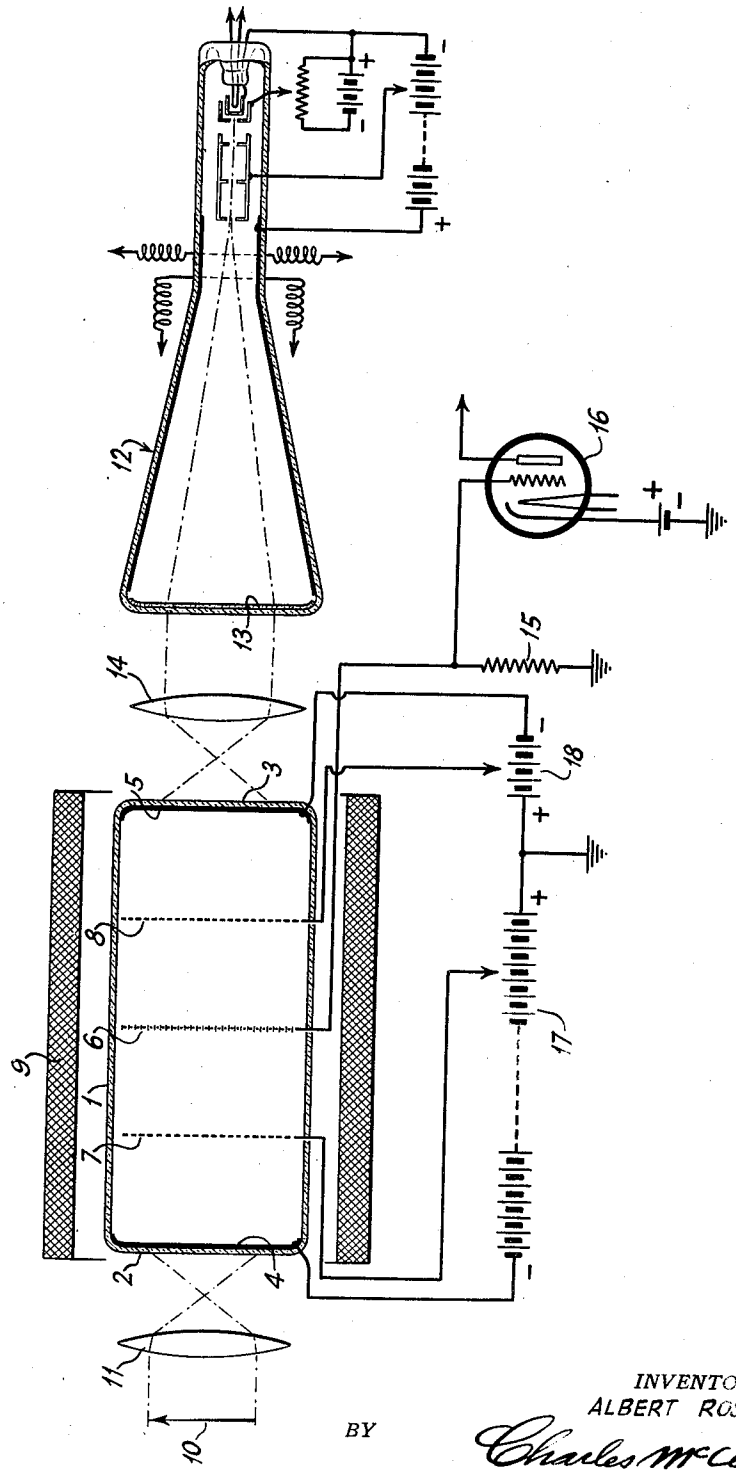
Aug. 27, 1940. A. ROSE 2,213,173

TELEVISION TRANSMITTING TUBE

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Fig. 1



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Fig. 2

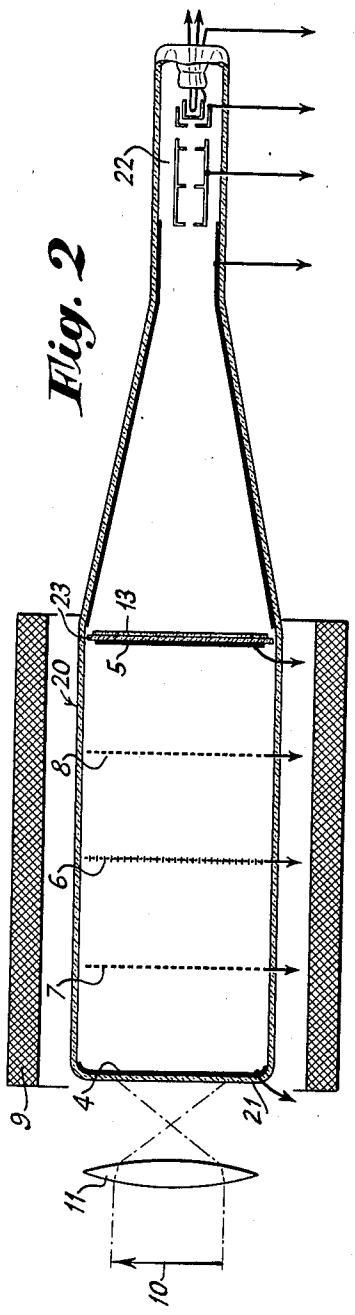
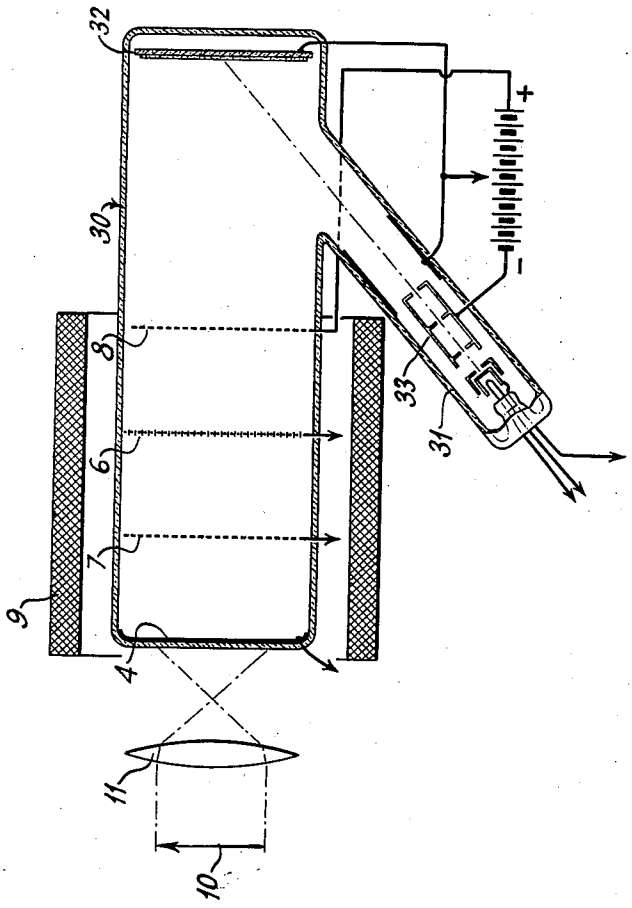


Fig. 3



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UNITED STATES PATENT OFFICE

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TELEVISION TRANSMITTING TUBE

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Application September 23, 1937, Serial No. 165,250

3 Claims. (Cl. 250—150)

My invention relates to electron discharge apparatus of the television transmitting type, and more particularly to improved television transmitting tubes and methods of operating such tubes in transmitting systems.

In many cathode ray television transmitting tubes an optical image causes the elemental areas of a mosaic electrode to acquire electrostatic charges, which form what may be termed an electrostatic image of the projected optical image, and which are neutralized to produce signals by scanning the mosaic electrode with an electron beam. If a high velocity scanning beam is used, secondary electrons are emitted from the surface of the mosaic electrode at the point of impact of the beam, and are attracted by those elemental areas of the mosaic which are more positive, thereby resulting in non-uniform distribution of the secondary electrons and consequent unequal neutralization of the charges on these elemental areas. Such non-uniform distribution produces a spurious signal commonly referred to as "black spot." In addition, the return of secondary electrons at random to the surface of the mosaic decreases the quantity utilized in generating the signal with a consequent loss in efficiency of operation. A further reduction in the efficiency of the tube is caused by the fact that the potential difference between the elemental areas and the collector electrode becomes so small that the photoemission from the elements soon reaches a maximum or saturated value. It has therefore been proposed to reduce the velocity of the scanning beam so that it will produce little or no secondary electrons upon impingement with the mosaic, but such a low velocity scanning beam cannot be scanned accurately over the surface of the mosaic electrode. In an attempt to improve the accuracy of scanning it has been proposed to place close to and co-extensive with the mosaic electrode a semi-transparent photocathode which is scanned by a rapidly moving spot of light on the side opposite that facing the mosaic electrode and to direct the electrons from the illuminated areas of the cathode to corresponding areas on the mosaic electrode. The translucent photocathode must be very close to the mosaic electrode to prevent dispersion of the electron streams produced by the scanning light spot. Such dispersion would necessarily result in electrons reaching a greater area of the mosaic electrode than the area of the scanning light spot and as a consequence, produce poor resolution in the operation of the device. However, a photoelectrically sensitive cathode close to the mosaic electrode seriously limits the output of such a device because the capacity between them by-passes and weakens the signal.

One object of my invention is to provide a television transmitting tube of greater sensitivity capable of producing television signals which are of greater intensity than those obtained in the usual way and which may be obtained without appreciable distortion. Another object of my invention is to provide a mosaic electrode tube which may be scanned without the introduction of spurious signals or dark spot phenomena.

In accordance with my invention an electrostatic image corresponding in electrostatic energy distribution to the light distribution of an optical image is formed on a mosaic electrode which is scanned by low velocity electron streams originating at a flying spot produced where a scanning beam or ray of radiant energy impinges on a scanned surface which is so remote from the mosaic electrode that its electrostatic capacity therewith is negligible, the electron streams from the flying spot being focused on the mosaic electrode by a uniform magnetic field.

According to another feature of my invention an intensified electrostatic image is formed on the mosaic electrode which is scanned with low velocity streams of photoelectrons derived from a photoelectrically sensitive surface which is remote from the said mosaic electrode and which is scanned by a moving light spot focused on it, the electron streams being focused from the sensitive surface onto the mosaic electrode by a uniform magnetic field.

According to a further feature of my invention the intensified electrostatic image on the mosaic electrode may be neutralized by low velocity secondary electrons which are produced by scanning with a high velocity electron beam an electrode so remote from the said mosaic electrode as to give the desired minimum of capacity therewith. The secondary electrons are focused onto the mosaic electrode by a substantially uniform magnetic field.

A better understanding of my invention will be obtained and other objects, features, and advantages of my invention will appear from the following description taken in connection with the accompanying drawings in which,

Figure 1 is a longitudinal view, partially in section, illustrating one form of my television transmitting tube and its attendant circuits,

Figure 2 is a longitudinal view, partially in section, illustrating one modification of my invention, and

Figure 3 is a longitudinal view illustrating another modification of my invention.

Referring to Fig. 1 my television transmitting tube comprises a highly evacuated cylindrical envelope or bulb 1 closed at each end by optically uniform and transparent sections 2 and 3 which have on their inner surfaces semi-transparent photoelectrically sensitive cathodes 4 and 5. Situated between the photoelectrically sensitive cathodes is a mosaic electrode 6 of the double-sided type, such as disclosed by Hickok in U. S. Patent 2,047,369. To form the electrostatic image there is mounted between the mosaic electrode 6 and the photoelectrically sensitive cathode 4 on which the optical image is focused and which will be referred to as the image cathode, a wire mesh accelerating electrode 7, which is preferably of relatively fine mesh with interstices which correspond in size to the elemental areas of the mosaic electrode 6. To assist in scanning the electrostatic image there is between the mosaic electrode 6 and the other photoelectrically sensitive cathode 5, from which the scanning stream originates, and which will be referred to as the scanning cathode, a wire mesh accelerating electrode 8, preferably of relatively coarse mesh, but which, however, may be a ring type electrode, preferably of conducting material on the wall of the envelope 1 between the cathode 5 and mosaic electrode 6. The scanning cathode 5 and the accelerating electrode 8 are so remote from the mosaic electrode that the electrostatic capacity of these electrodes with the mosaic electrode is negligible. I have found that a minimum distance of one inch between the mosaic electrode 6 and the scanning cathode 5 is desirable. Surrounding the envelope 1 and preferably extending slightly beyond each of the photocathodes 4 and 5 is a single electron focusing coil 9 for the purpose of focusing electrons from the image cathode 4 to the mosaic electrode 6 which electrons are liberated under the influence of a light image represented by the arrow 10 focused onto the cathode 4 by the lens system 11. The focusing coil 9 also focuses the scanning electrons from the scanning photocathode 5 onto the mosaic electrode 6 which electrons are liberated under the influence of a flying light spot from a conventional cathode ray tube 12 having a fluorescent screen 13, and focused on the scanning photocathode 5 by the lens system 14. Since the single focusing coil 9 extends over the space separating the photocathodes 4 and 5 the field which it generates is continuous therebetween, perpendicular to both of the photocathodes, and likewise perpendicular to the mosaic electrode. It is desirable to make the fluorescent screen 13 of material which has little phosphorescence after being scanned by the cathode ray beam. A material having this characteristic is calcium tungstate which may be applied to the inner face of the cathode ray tube 12. A commercially available cathode ray tube having the desired fluorescent screen characteristics is known as the RCA 907 cathode ray tube. The cathode ray tube 12 is conventional, having the usual cathode and electron beam focusing anodes by the cooperative action of which an electron beam is directed to the fluorescent screen in the usual manner.

As customary in the art the foundation or signal electrode of the mosaic electrode 6 is connected to ground through the usual load impedance 15 and to the input electrode of a translating device such as the triode 16. The photoelectrically sensitive image cathode 4 is maintained at a relatively high negative potential with respect to the foundation of the mosaic electrode 6 by the battery 17, this battery likewise serving as a potential source for the fine wire mesh electrode 7. The scanning cathode 5, preferably operated at a small negative potential with respect to the mosaic electrode 6, is shown connected to the battery 18 which likewise provides a low positive potential on the electrode 8 with respect to the scanning cathode 5.

The semi-transparent cathodes 4 and 5 may be made by vaporizing and condensing a small quantity of silver as a semi-transparent film on the sections 2 and 3. The silver as it condenses on the surface to be coated forms a film which changes in color with transmitted sunlight from yellow to brown to purple and to blue. The evaporation of silver is discontinued between the purple and blue stages whereupon the silver film is completely oxidized by subjecting the film to a glow discharge in the presence of oxygen. Excess oxygen is pumped from the tube and caesium is admitted, and the tube is baked for five minutes at approximately 200° C. to sensitize the silver oxide film. It has been found that with such treatment an excellent electrically conducting photoelectrically sensitive surface is obtained.

In operation an optical image such as represented by the arrow 10 is projected and focused upon the image cathode 4 by the lens system 10, electrons being liberated in the form of electron streams in accordance with the elemental areas of light and shade of the optical image and projected at high velocity upon the mosaic electrode 6 in the form of an electron image. By reason of the potential differences of the mosaic electrode 6 and the wire mesh electrode 7 with respect to the image cathode 4, a high velocity is imparted to the photoelectrons from the image cathode 4 and upon impingement with the mosaic electrode 6, secondary electrons are liberated which in quantity exceed the photoelectrons. A positive electrostatic image on the mosaic electrode is formed by the loss of these secondary electrons. The fluorescent screen 13 of the cathode ray tube 12 is scanned by an electron beam to form a pattern, preferably consisting of horizontal lines, each displaced from the preceding in a direction normal to the lines, and an optical image of the pattern is projected upon the scanning cathode 5 by the lens system 14 and forms in effect a scanning light spot on the scanning cathode 5. Photoelectrons are liberated from the photocathode 5 under the influence of the scanning light spot and are directed as a low velocity electron stream toward the mosaic electrode 6 by the potential differences between the mosaic electrode 6 and the accelerating electrode 8 with respect to the cathode 5 and focused upon the mosaic electrode by the magnetic field produced by the focusing coil 9. The focusing coil 9 is designed and energized to produce a sufficiently strong magnetic field to focus the electrons onto the mosaic electrode. I have found that a field strength of 75 gausses is sufficient to obtain resolution of 150–200 lines, but I have found that even greater resolution may be obtained by increasing the strength of this field to several hundred gausses. The potentials applied to the scanning cathode 5 and the accelerating electrode 8 with respect to the mosaic electrode are so adjusted that the electrons from the cathode 5 reach the mosaic electrode 6 with little or no velocity. Elemental areas of the mosaic electrode 6 which are positive by reason of high velocity

photoelectrons from the image cathode 4 having impinged thereon and releasing secondary electrons are neutralized by the electrons from the scanning cathode 5, whereas electrons directed toward elemental areas of the mosaic electrode which are not charged positively do not fall on these elemental areas but return to the electrode 8 or the scanning cathode 5 where they are collected. By the choice of suitable operating potentials of a low value between the scanning cathode 5 and the mosaic electrode 6 it is possible to obtain neutralization of the charges constituting the electrostatic image on the elemental areas of the mosaic electrode without material liberation of secondary electrons from the scanned side of the mosaic electrode. Even if a small quantity of secondary electrons results from the low velocity scanning the magnetic focusing field produced by the magnetic coil 9 prevents their distribution over the surface of the mosaic electrode. As a consequence distortion of the electrostatic image held on the mosaic electrode is prevented.

A preferred embodiment of my invention, such as shown in Fig. 2, combines the advantages of my invention in a single envelope rather than in two tubes as shown in Fig. 1. The tube shown in Fig. 2 comprises an evacuated envelope 20, one portion of which is cylindrical in shape, one end being closed by an optically uniform transparent window 21 having on its inner surface a semi-transparent photoelectrically sensitive surface to form the image cathode 4, the opposite end being terminated with a frusto-conical section and a neck section enclosing a conventional cathode ray electron gun 22. The other part of the structure and electrical connections are the same and are similarly referenced as in Fig. 1. Between the frusto-conical section of the envelope 20 I provide the photoelectrically sensitive scanning cathode 5 facing the mosaic electrode 6 and formed on one side of a transparent base 23, such as mica, the opposite side bearing the luminescent screen 13. The operation of the tube shown in Fig. 2 is similar to that described in connection with Fig. 1, the only difference being that a single envelope houses both the mosaic electrode, its attendant structure, and the parts of the conventional cathode ray tube shown in Fig. 1.

A further embodiment of my invention, such as shown in Fig. 3, comprises an evacuated envelope 30 of cylindrical form with an elongated neck section 31 near one end of the envelope, the longitudinal axis of the neck section being disposed at an angle with respect to the longitudinal axis of the cylindrical section. The mosaic electrode 6, wire mesh accelerating electrodes 7 and 8, photoelectrically sensitive image cathode 4, and electron focusing coil 9 are similar to those shown in Figs. 1 and 2 and are similarly disposed with respect to each other. At the end of the cylindrical section opposite that bearing the image cathode 4, I provide an electron emitter or target electrode 32, preferably of a material having a high secondary to primary electron emission characteristic, so positioned as to be parallel with the mosaic electrode 6 and to be scanned by an electron beam generated by a conventional electron gun 33 in the neck section 31. The target electrode 32 may comprise a sheet of silver which has been oxidized and exposed to caesium vapor, such a target having the desired secondary electron emission characteristics.

In the operation of my new and improved tube as shown in Fig. 3 an electrostatic image of the optical image to be transmitted is formed on the mosaic electrode 6 in a manner similar to that described in connection with Fig. 1. The electrode 32 is scanned by a high velocity electron beam, generated and focused on the electrode 32 by the gun structure 33. Under electron bombardment the electrode 32 emits secondary electrons which are accelerated toward the mosaic electrode 6 by the accelerating electrode 8 and focused upon the mosaic in the form of an electron pattern corresponding to the scanning pattern on the electrode 32 by the focusing coil 9.

Positive potentials are applied to the target electrode 32 and the wire mesh accelerating electrode 8 with respect to the foundation of the mosaic electrode 6 and are so adjusted that the secondary electrons released by the impinging electron beam on the target electrode are accelerated toward and focused upon the mosaic electrode by the focusing coil 9 so that they reach the mosaic electrode with a low velocity, preferably at a velocity insufficient to liberate secondary electrons from the surface of the mosaic electrode. The electrostatic image formed on the mosaic electrode 6 by the photoelectrons from the image cathode 4 under the influence of a light image, such as represented by the arrow 10, is neutralized by the secondary electrons liberated from the target electrode 32, electrons which are directed toward elemental areas retaining a positive charge being collected by the elemental areas and electrons directed toward elemental areas having no positive charge thereon being returned to the wire mesh electrode 8 or the target 32.

In each of the three modifications of my invention which have been described above, the focusing coil 9 focuses the scanning electrons onto the mosaic electrode 6 in a pattern which is similar to the pattern formed by the high velocity beam from the electron gun. It is therefore evident that the elemental areas of the mosaic electrode which retain the electrostatic charges making up the electrostatic image may be scanned in a definite sequence, inasmuch as the focusing coil 9 produces a magnetic field which gives the same distribution of electrons on the mosaic electrode 6 as emanating from the scanning cathode 5 or the emitter or target electrode 32. The electrostatic image on the mosaic electrode may, therefore, be systematically neutralized point by point by the low velocity electrons without introducing in capacitive relation with respect to the mosaic electrode an electrode which would be effective in shunting the signalling energy produced by the scansion of the mosaic electrode.

From the foregoing description it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, than only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim:

1. A television transmitting tube comprising an evacuated envelope enclosing a double-sided mosaic electrode including an electrically insulated base and a plurality of mutually insulated metallic elements extending through said base, a photo-electrically sensitive cathode having an extended surface parallel to and spaced by a distance of at least one inch from said mosaic electrode to render the capacity between said cathode and said mosaic electrode negligible, means including a second photo-electrically sen-

sitive cathode similarly positioned on the opposite side of said mosaic electrode from said first-mentioned cathode to produce on said mosaic electrode an electrostatic image consisting of positive charges representative of the light and shade areas of an optical image, means to scan said first-mentioned cathode with a flying spot of light to liberate a stream of electrons from the scanned portion of said cathode, means between said first-mentioned cathode and said mosaic electrode to project on said mosaic electrode the stream of electrons at a velocity lower than that required to liberate secondary electrons in excess of the number of electrons of the stream, to neutralize the electrostatic image of positive charges on said mosaic electrode and magnetic means to generate a magnetic field having lines of force perpendicular to both of said cathodes and said mosaic electrode to direct electrons liberated from areas on each of the said photocathodes to correspondingly positioned areas on said mosaic electrode.

2. A television transmitting tube comprising an evacuated envelope enclosing a double-sided mosaic electrode including a plurality of mutually separated and electrically insulated elements, an emitter electrode adapted to liberate secondary electrons when bombarded by a cathode ray beam, said emitter electrode having an extended surface parallel to and spaced from said mosaic electrode to render the electrostatic capacity between said emitter and said mosaic electrode negligible, means comprising an anode between said emitter and said mosaic electrode to project the secondary electrons upon said mosaic electrode at a velocity lower than that required to liberate additional secondary electrons in excess of the number of secondary electrons liberated from said emitter, means including a photo-electrically sensitive electron emitting cathode having an extended surface parallel to and spaced apart from said mosaic electrode and on the side thereof opposite said emitter to form an electrostatic image on said mosaic electrode, means to project a cathode ray beam on said emitter, means to scan said beam over said emitter in two mutually perpendicular directions to liberate a stream of secondary electrons from the place on said emitter bombarded by the scanned beam and a single magnetic coil surrounding said envelope and extending over the entire space between and slightly beyond said anode and said photocathode to focus the secondary electron stream from said emitter electrode upon said mosaic electrode and an electron image from said cathode on said mosaic electrode.

3. A television transmitting tube including an evacuated envelope, a double-sided mosaic electrode having an electrically conductive foundation and a plurality of metallic elements extending through said foundation and electrically insulated from each other and from said foundation, a photo-electrically sensitive cathode facing one side of and parallel with said mosaic electrode to liberate electrons as an electron image and form on said mosaic electrode an electrostatic image of an optical image on said cathode and a second photo-electrically sensitive cathode facing the opposite side, parallel to and spaced from said mosaic electrode by a distance of at least one inch to render the capacity between said cathode and said mosaic electrode negligible, means for scanning said cathode with a moving spot of light to liberate a stream of electrons from said cathode at the place illuminated by said spot of light and a single magnetic focusing coil extending over the entire space between said cathodes to focus the electron image from said first-mentioned cathode and the electron stream liberated from said second cathode on to said mosaic electrode.

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