

March 23, 1943.

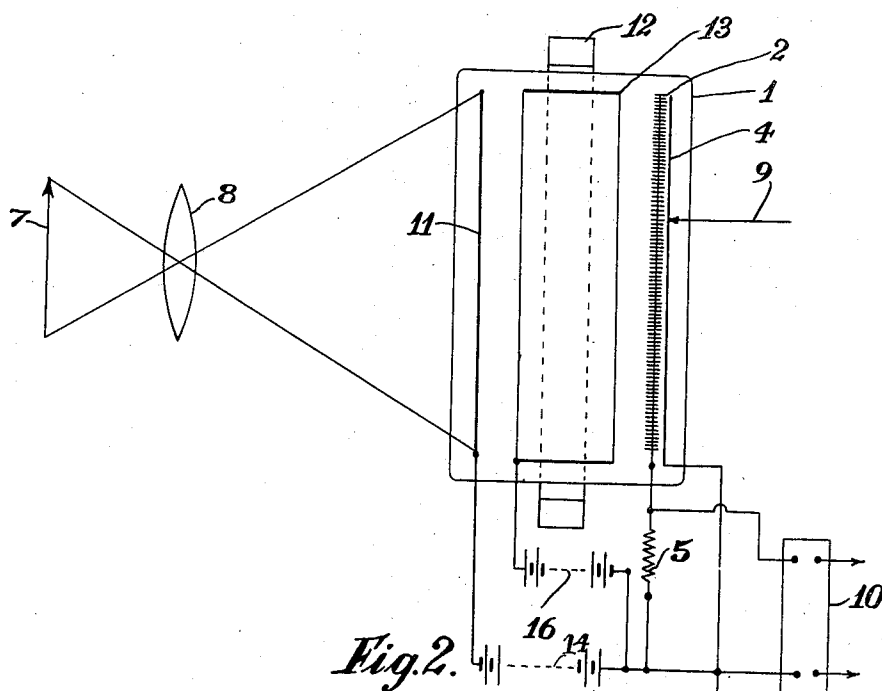
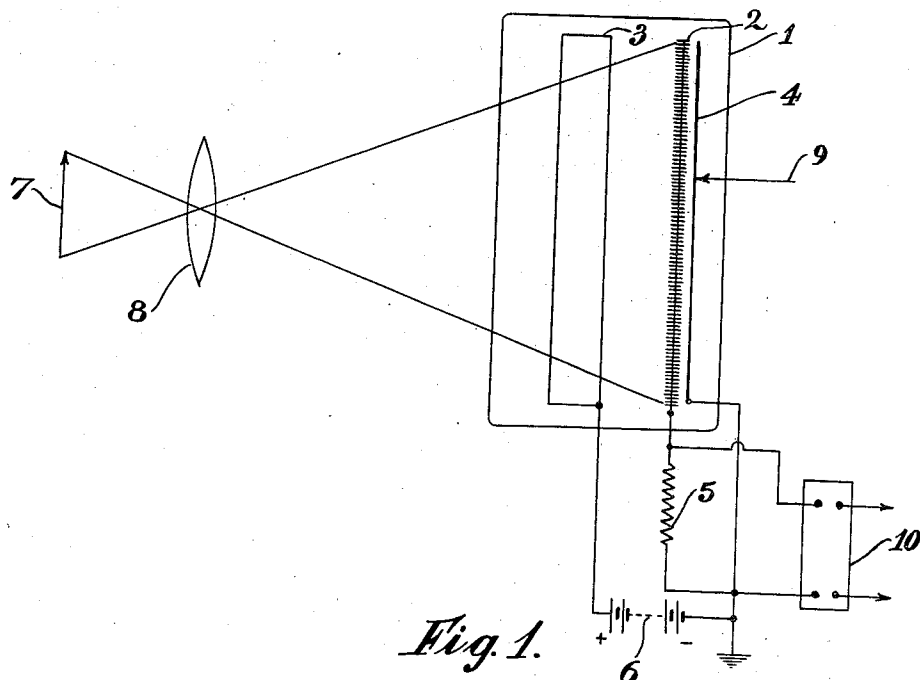
H. G. LUBSZYNSKI

2,314,648

TELEVISION TRANSMITTING AND THE LIKE SYSTEM

Filed Sept. 10, 1936

2 Sheets-Sheet 1



INVENTOR
HANS G. LUBSZYNSKI
BY *H. S. Brown*
ATTORNEY

March 23, 1943.

H. G. LUBSZYNSKI

2,314,648

TELEVISION TRANSMITTING AND THE LIKE SYSTEM

Filed Sept. 10, 1936

2 Sheets-Sheet 2

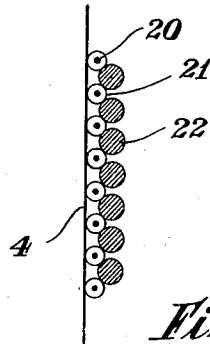


Fig. 3.

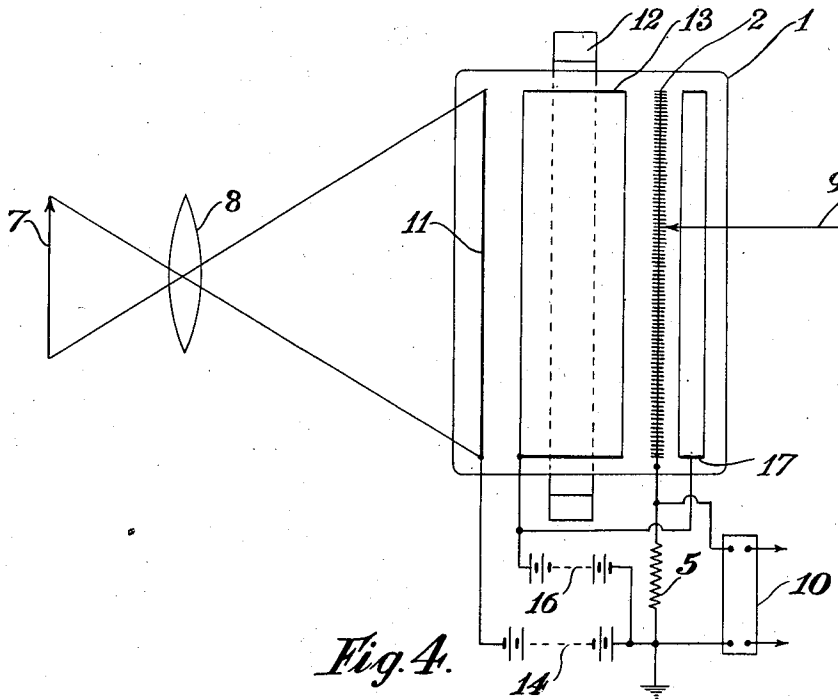


Fig. 4.

INVENTOR
HANS G. LUBSZYNSKI
BY *H. S. Swann*
ATTORNEY

UNITED STATES PATENT OFFICE

2,314,648

TELEVISION TRANSMITTING AND THE LIKE
SYSTEM

Hans Gerhard Lubszynski, Hillingdon, England,
assignor to Electric & Musical Industries Limited,
Hayes, Middlesex, England, a company of
Great Britain

Application September 10, 1936, Serial No. 100,087
In Great Britain September 24, 1935

19 Claims. (Cl. 178—7.2)

The present invention relates to television and the like transmitting systems in which a mosaic screen of the double-sided type is used.

A mosaic screen of the double sided type may be defined as a mosaic screen having a perforated conducting signal plate, and a large number of conducting elements which present exposed surfaces on both sides of the mosaic screen, which are insulated from one another and from the signal plate and which lie in close proximity to the signal plate, to which they therefore have substantial capacity.

The exposed surfaces of the elements need not necessarily be visible on both sides of the mosaic screen, but it is essential that electrons should be able to reach the elements from both sides of the screen. The capacity of the elements to the signal plate is preferably as large as possible, and is preferably greater than or of the same order as the capacity of the elements to one another.

The signal plate may have the form of a grid of insulated wires which are held together by adhesion between the insulating coverings. A method of forming such a grid is fully described in U. S. application Serial No. 44,316 filed October 10, 1935. The holes in the grid may be filled with conducting rivets, to form the mosaic elements. Alternatively each hole may be covered by a silver ball of diameter slightly larger than the hole in the grid, and these balls may be secured to the insulating material by heating the screen and thus fusing the insulating material which may be glass for example.

In the operation of a tube containing such a mosaic screen, it is arranged that the elements, and therefore the condensers formed between the elements and the signal plate, acquire charges preferably at a rate which is proportional to the amount of light emitted from a corresponding elemental area of the object, these charges together forming what will be called an electrostatic image of the object. The elements are scanned by suitable means (for example a cathode ray beam) and thereby the charges on the elements, and therefore the charges on the condensers formed between the elements and the signal plate, are successively discharged to a substantially fixed datum level of potential. The sudden discharges of these condensers result in pulses of current which pass through an impedance connected in circuit with the signal plate and potential differences proportional to the charges acquired by the elements between successive scanings are thus set up across the

impedance. These potential differences are amplified and transmitted as picture signals.

A television transmission system employing a double sided mosaic screen is known in which the conducting mosaic elements are photo sensitised on the side on which the image is projected, and the screen is scanned on the other side by a cathode ray beam. Each element, in the intervals between the moments when it is scanned, emits "photo-electrons" owing to its photo-electrically active properties, and acquires a positive charge, which is proportional to the amount of light falling upon it from the object. The photo-electrons are collected by an electrode held at a suitable positive potential relative to the elements. In this way what will be referred to as a positive electrostatic image is formed on the screen.

In order that scanning may restore the elements to a datum potential, scanning must give the elements a negative charge, that is, electrons must be supplied to the elements. If it is attempted to supply these electrons from a high-velocity cathode ray beam, then, on account of the copiousness of the secondary electrons liberated from the elements by impact of the primary beam, a net positive charge may accumulate on the elements and the neutralisation of the positive picture charges is then not effected. Thus, the potentials of the elements must increase until the elements have potentials in the neighbourhood of the potential of the anode which is used to collect the photo emission. No fixed datum potential other than this can be reached. The potential difference between the elements and the collector anode thus becomes so small that the photo-emission from the elements does not reach its maximum saturated value with a consequent loss in efficiency of operation of the tube. A further reduction in the efficiency of the tube is caused by the fact that by no means all of the electrons of the secondary emission proceed to the electrode intended to collect them; some spread to any neighbouring elements which are more positive than the elements from which they were emitted. Thus an element is being continuously discharged when the scanning beam is in its neighbourhood, and not only when the scanning beam actually falls upon it. The efficiency of the known methods where secondary electron emission effects occur is usually only about 5% of the theoretical value.

In another television transmission system, described in U. S. application Serial No. 19,752, a positive electrostatic image is formed upon a

double-sided mosaic screen by projecting on to a photo-electrically active screen of non-mosaic character an optical image of the object to be transmitted; the electrons emitted from each point on the photo-electrically-active screen, in number proportional to the intensity of the light falling on that point, are accelerated towards and focussed upon the double-sided mosaic screen, which is not necessarily photo-electrically active. The accelerating field is usually made such that the velocity of the electrons on impact with the elements of the mosaic screen, is such as to cause secondary electrons to be emitted from the elements in greater number than the incident photo-electrons. The net effect is therefore that the elements lose electrons, and become positively charged. A positive electrostatic image is thus formed on the mosaic screen.

In a modified arrangement described in the specification of co-pending application Serial No. 62,898 filed February 9, 1936, the velocity of the electrons is such that fewer secondary electrons leave when primary electrons arrive, and the electrostatic image is then negative. The charge on the mosaic screen is neutralised by scanning the side thereof remote from the photo-electrically-active screen by means of a cathode ray beam. In these systems, also, disadvantages similar to those met with in the first mentioned system are encountered.

It is an object of the present invention to provide improved methods of television transmission in which these and other disadvantages caused by secondary electron emission are removed.

According to the principal feature of the present invention there is provided a method of transmitting images of an object to a distance wherein an electrostatic image of an object is formed upon a mosaic screen of the double sided type comprising a large number of conducting elements insulated from one another and from a common signal plate with which they are capacitively associated and wherein the elements of said screen are periodically brought to a substantially fixed datum level of potential the periodic restoring of the potential of each element to the datum level giving rise to picture signals in a circuit associated with said signal plate owing to the capacity existing between said signal plate and said elements, the method being characterised in that the elements are brought to said datum level of potential by a transference of electrons between said elements and an auxiliary electrode co-operating with said mosaic screen, said transference being brought about by a scanning light beam. The term light beam in this specification is to be given its broad meaning, and the term is not restricted to radiation which lies in the visible portion of the spectrum. The term is intended to include X-rays and rays lying in the infra-red and ultra-violet regions of the spectrum.

Where a positive electrostatic image is formed on the mosaic screen, photo-electric material may be provided upon the auxiliary electrode and when scanned by the light spot the photo-electric material emits low velocity electrons which pass to the mosaic elements to neutralise the charges thereon. Where the electrostatic image is a negative image, the mosaic elements may have upon them photo-electric material which is scanned by the light spot and the low

velocity electrons so liberated pass to the auxiliary electrodes.

Other features of the invention, including apparatus for carrying out the methods of the present invention set forth above, will be apparent from the following description and from the appended claims.

The invention will now be described with reference to the accompanying diagrammatic drawings in which

Figs. 1, 2 and 4 illustrate forms of apparatus according to the present invention and

Fig. 3 shows a modification of a detail of the apparatus shown in Figs. 1 and 2.

Referring to Fig. 1, in an evacuated envelope 1 is arranged a mosaic screen 2 of mutually insulated elements. This screen may consist of a grid of wires covered with insulating material, the holes of the grid being filled with metal rivets, which are coated on one side with photo-electrically active material such as caesium and on the other left uncoated. Near to the mosaic screen and on the side on which the photo-electrically active coating is formed (the left hand side as seen in Fig. 1), is placed an annular electrode 3, and on the other side of the mosaic screen and close thereto is placed a transparent photo-electrically active screen 4.

The wires of the grid of the mosaic screen 2 are all electrically connected together to form the signal plate, for instance by welding their ends to a metal supporting frame, and a lead is taken from this frame to the outside of the envelope, and connected to earth through a signal resistance 5 of a suitable high value. Leads are also taken from the annular electrode 3 and the transparent photo-electrically active screen 4. The latter is connected directly to earth, and the annular electrode is connected to the positive terminal of a source of potential 6, the negative terminal of the source being earthed. The operation of the apparatus is as follows:

An optical image of an object 7 to be transmitted is formed by means of a suitable optical system shown diagrammatically at 8 upon the left hand, that is the photo-electrically active surface of the mosaic screen 2, and the side of the transparent photo-electrically active screen 4 remote from the mosaic screen is scanned by a spot of light formed by a narrow beam of light indicated at 9. The photo-electrons emitted from the photo-electrically active side of the mosaic screen 2 are drawn off on to the positive annular electrode 3, and in the intervals between scans each element becomes positively charged to an amount proportional to the amount of light from the object 7 falling on it. A positive electrostatic image of the object 7 is thus formed on the mosaic screen 2. In consequence of the scanning operation photo-electrons are liberated from the photo-electrically active screen 4, and, since the elements of the mosaic screen 2 have become charged positively, these electrons move towards the element immediately opposite the point at which they are produced by the scanning light beam 9 and neutralise the charges on elements in turn. Since there is capacity between the elements of the mosaic screen 2 and the grid of wires constituting the signal plate, charges will be induced in the grid corresponding to the charges on the elements which have been neutralised by the scanning electrons and which correspond to the average intensity of the light from the object 7 which

has fallen on the element being scanned since the last time it was scanned. These induced charges, passing through the resistance 5, set up potential differences which are amplified in an amplifier indicated at 10 and transmitted.

Another way of carrying the present invention into effect will be described with reference to Fig. 2 of the accompanying drawings. Referring to Fig. 2 there are arranged in an evacuated envelope 1 first a transparent photo-electrically-active screen 11 of non-mosaic character, and a double-sided mosaic screen 2 constructed as described above with the exception that there is no photo-electrically-active coating on the elements. These two screens 11 and 2 are spaced apart from one another, and, surrounding at least a part of the space between them is arranged an electron focusing system shown in the present example as an electromagnetic coil 12. Also surrounding a part of the space between the photo-electrically active screen 11 and the mosaic screen 2 is an annular electrode 13. On the side of the mosaic screen 2 remote from the photo-electrically-active screen 11 is arranged a second photo-electrically-active screen 4 placed near the mosaic screen 2. The first photo-electrically-active screen 11 is connected to the negative terminal of a source of potential 14, the positive terminal of which is earthed; the signal plate is connected to earth through a resistance 5, and the second photo-electrically-active screen 2 is connected directly to earth. The annular electrode 13 is connected to the positive terminal of a source of potential 16, the negative terminal of which is earthed.

The operation of the apparatus of Fig. 2 is as follows:

An optical image of the object 7 to be transmitted is projected by means of an optical system 8 upon the first photo-electrically-active screen 11 on the side thereof remote from the mosaic screen 2. Photo-electrons emitted from any point on this photo-electrically-active screen 11 are accelerated towards the mosaic screen 2 and focused upon a corresponding point thereon by reason of the potential difference existing between the two screens 11 and 2 and the electron focusing system 12 surrounding the space between them. The acceleration is arranged to be such that the photo-electrons on striking an element of the mosaic screen 2 cause the emission therefrom of secondary electrons greater in number than the incident photo-electrons. These secondary electrons are collected by the annular electrode 13. In this way each element acquires a positive charge proportional to the amount of light from the object 7 falling on the corresponding point on the first photo-electrically-active screen 11, so that a positive electrostatic image is formed on the mosaic screen 2. The second photo-electrically-active screen 4 is scanned by a beam of light 9 and slow moving photo-electrons from the screen 4 are attracted to the mosaic elements opposite and neutralise the charges thereon as described previously. Picture signal voltages appearing across the resistance 5 connected in series with the signal plate, and which result from the discharge of the elements, are amplified in the amplifier 10 and transmitted.

In both the examples above described, the photo-electrically-active screen 4 which is scanned by the light spot is preferably placed in close proximity to the mosaic screen 2 by sep-

arating it therefrom by insulating spacers of suitable thickness.

In certain forms of mosaic screen the insulation between the elements projects beyond the elements, in other words the elements are contained in recesses in the insulation of the screen. When such forms of mosaic screens are used the photo-electrically-active screen which is scanned by the light spot may be placed in contact with the mosaic screen, the projecting insulation however preventing the elements themselves from making contact with the screen. For example, as shown in Fig. 3, a mosaic screen comprises a signal plate in the form of a wire grid, the wires of which running in one direction are shown at 20; the wires are coated with insulating material 21. The elements comprise silver balls 22 the diameters of which are larger than the interstices of the insulated grid, and which are secured to the insulating material of the grid, for example by fusion. The photo-electrically-active screen 4 is held in contact with the insulating material 21 of the mosaic screen on the side thereof remote from that on which the balls 22 are arranged. The advantage of this arrangement is that the photo-electrons emitted by the screen 4 under the influence of the light spot can only proceed to the mosaic element immediately opposite so that spreading of the photo-electrons, which would give rise to "fogging" of the picture signals, is prevented.

Instead of forming a positive electrostatic image on the mosaic screen a negative image may be formed. Apparatus in which such an electrostatic image is formed and used to produce picture signals for transmission is shown in Fig. 4. In that figure the arrangement of electrodes to the left of the mosaic screen 2 is the same as that described with reference to Fig. 2, but it is arranged that the velocity of photo-electrons arriving from a photo-sensitive screen 11 on which an image of the object 7 is formed and the nature of the mosaic surface struck by the photo-electrons are such that the number of secondary electrons leaving is less than the number of primary photo-electrons arriving. Thus where the mosaic elements are of silver for example they may be coated with a material which emits few secondary electrons when bombarded with high velocity electrons; a suitable material for this purpose is carbon. Alternatively the elements may be formed of such a material, for example aluminium. The mosaic elements are coated on the right hand side, that is the side remote from the photo-sensitive screen 11, with photo-sensitive material which is scanned by a light spot formed by the light beam 9. Where the elements are not of silver, preferably a layer of silver is formed on the elements and the photo-sensitive material deposited on this layer. The photo-electrons so emitted are collected by the annular electrode 17 which is held at a positive potential relative to earth and to the screen 2, for example by connecting it to the positive terminal of the source of potential 16 which also serves to give the annular electrode 13 a positive potential and the mosaic elements are thus successively discharged.

In the arrangements described, the electrode 13 for collecting secondary electrons (and in the last described example also the electrode 17 for collecting photo-electrons) from the mosaic screen 2 have been of annular form. They may, however, be in the form of grids or in the case of electrode 17, through which only light and

not electrons have to pass, in the form of transparent material such as mica coated with a transparent layer of conducting material such as metal.

In the arrangements described with reference to Figs. 2 and 4 there may be provided means for amplifying the photo-electron emission from the photo-electrically active screen 11 before it falls on the mosaic screen 2. Such means may utilise the phenomenon of secondary electron emission and may have any of the forms described in co-pending application Serial No. 82,300 filed May 28, 1936.

The scanning light spot 9 in the above described examples may be produced in a variety of ways. One way is to use any well known or suitable mechanical scanning arrangement such as a mirror drum to sweep a beam of light over the transparent photo-electrically-active screen 4 or the right hand side of the mosaic screen 2 in Fig. 4. Preferably however the scanning beam is produced from a cathode ray tube. The beam of the tube is caused to sweep over the fluorescent screen of the tube in a series of contiguous parallel lines. An image of this screen is projected upon the transparent photo-electrically-active screen (or the mosaic screen in Fig. 4), and the image of the spot of light on the fluorescent screen acts as a scanning light spot. This method of producing a scanning spot of light gives sufficient illumination where the amount of light falling on the mosaic screen from the object 7 is not high. If it is desired to work with a high intensity of illumination, in the arrangements of Figs. 1 and 2, more light in the scanning spot may be obtained by coating the transparent photo-electrically-active screen 4 on the side thereof remote from the mosaic screen 2, with a layer of fluorescent material and scanning this fluorescent layer with a cathode ray beam, the electron gun producing the beam being enclosed in the same vessel 1 as the other parts of the apparatus. In the arrangement of Fig. 4 a fluorescent screen may be placed very close to the right hand, that is the photo-electrically-active side of the mosaic screen 2. The screen is then scanned by a cathode ray beam. The use of a fluorescent screen placed close to the scanned photo-electrically-active surface or elements is estimated to give some 50 times more light than the method where an image of the fluorescent screen is formed on the transparent screen 4 by optical projection. The focusing method however has the advantage that the cathode ray gun can be entirely separated from the mosaic screen 2.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. Apparatus for transmitting images of an object to a distance, said apparatus comprising a mosaic screen of the double sided type having a signal electrode and a large number of mutually insulated elements capacitively associated with said signal plates, means for forming on said mosaic screen an electrostatic image of an object to be transmitted, at least one electrode adapted to collect electrons emitted from said mosaic screen, a photoelectric surface, means to scan optically elemental areas of the photoelectric surface, a predetermined pattern to release electrons therefrom, means to discharge elemental portions of the electrostatic image by the released electrons, and means to produce signal currents in ac-

cordance with reduction of the elemental charges.

2. Apparatus for transmitting images of an object to a distance, said apparatus comprising a mosaic screen of the double sided type having a large number of conducting elements associated with a common signal plate, said elements being coated on one side with photoelectric material, means for projecting an optical image of an object to be transmitted upon the side of the mosaic screen whose elements are coated with the photoelectric material to charge each element to a potential dependent upon the intensity of light falling thereon, an electrode adapted to collect photoelectrons emitted by said elements, a photoelectrically active screen positioned adjacent said mosaic screen on the side thereof remote from that upon which said optical image is projected, means for producing a scanning light spot for scanning said photoelectrically active screen in accordance with a predetermined pattern to produce slow moving electrons, and means to periodically discharge said elements by the produced slowly moving electrons.

3. Apparatus for transmitting images of an object to a distance, said apparatus comprising a first photoelectrically-active screen, a mosaic screen spaced apart from said first photo-electrically-active screen, said mosaic screen being of the double-sided type and comprising a large number of conducting elements associated with a common signal plate, an electron lens system for focusing electrons emitted from said photo-electrically-active screen on to said mosaic screen to form an electrostatic image of said object thereon, a second photoelectrically active screen positioned on the side of the mosaic screen remote from the first photo-electrically active screen, optical means for releasing electrons from the second screen elemental area by elemental area in accordance with a predetermined pattern, and means to bring the potentials of the conducting elements sequentially to a fixed datum level of potential.

4. Apparatus for transmitting images of an object to a distance, said apparatus comprising a mosaic screen of the double-sided type and having a large number of conducting elements associated with a common signal plate, said elements being coated on one side with photo-electrically-active material, means for forming a negative electrostatic image of an object to be transmitted upon said mosaic screen and means for producing a scanning light spot for scanning the photo-electrically-active side of said mosaic screen to cause the emission of slow moving electrons from said elements and an electrode adapted to collect electrons emitted from the elements.

5. Apparatus as claimed in claim 1 wherein said means to scan the elemental areas comprise a cathode ray gun for projecting a beam of electrons on to a fluorescent screen to produce a light spot thereon, means for causing said beam of electrons to scan said fluorescent screen, and optical means for focusing an image of said spot on to the photoelectric surface.

6. Apparatus as claimed in claim 2 wherein said means for producing a scanning light spot comprise a cathode ray gun for projecting a beam of electrons on to a fluorescent screen to produce a light spot thereon, means for causing said beam of electrons to scan said fluorescent screen, and optical means for focusing an image of said spot on to the photoelectrically active screen.

7. Apparatus as claimed in claim 2 wherein said optical means comprise a cathode ray gun for pro-

jecting a beam of electrons on to a fluorescent screen to produce a light spot thereon, means for causing said beam of electrons to scan said fluorescent screen, and optical means for focusing an image of said spot on to the source of slow moving electrons.

8. Apparatus as claimed in claim 4 wherein said means for producing a scanning light spot comprise a cathode ray gun for projecting a beam of electrons on to a fluorescent screen to produce a light spot thereon, means for causing said beam of electrons to scan said fluorescent screen, and optical means for focusing an image of said spot on to the mosaic screen.

9. A television transmitting system comprising a transparent photoelectric screen, means to project an optical image upon the photoelectric screen, a double sided mosaic electrode positioned parallel to and in register with the photoelectric screen, means to focus the electrons released from the photosensitive screen upon the mosaic, a second photosensitive screen positioned in register with and adjacent to the side of the mosaic remote from the first photosensitive screen, a collector electrode positioned intermediate the first photosensitive screen and mosaic, an impedance connection between the mosaic and the second photosensitive screen, and an amplifying system connected across the impedance connection.

10. A television transmitting system comprising a transparent photoelectric screen, means to project an optical image upon the photoelectric screen, a double sided mosaic electrode positioned parallel to and in register with the photoelectric screen, means to focus the electrons released from the photosensitive screen upon the mosaic, a second photosensitive screen positioned in register with and adjacent to the side of the mosaic remote from the first photosensitive screen, a collector electrode positioned intermediate the first photosensitive screen and mosaic, means to scan the second photoactive surface by a light spot according to a predetermined pattern, an impedance connection between the mosaic and the second photosensitive screen, and an amplifying system connected across the impedance connection.

11. A television transmitting system comprising a transparent photosensitive screen, a double sided mosaic parallel to and in register with the screen, a collector electrode and an electron focusing system intermediate the photosensitive screen and mosaic, a second collector electrode adjacent to the mosaic on the side thereof more remote from the photosensitive screen, impedance means to scan the side of the mosaic most remote from the photosensitive screen by a light spot according to a predetermined pattern, an impedance connection between the photosensitive screen and mosaic, and amplifying means connected across the impedance connection.

12. Apparatus as claimed in claim 2 wherein on the side of said mosaic screen which is scanned, insulating material projects beyond the exposed surfaces of said elements and wherein the photo-electrically-active screen which is scanned by said light spot is placed in contact with said insulating material.

13. Apparatus as claimed in claim 3 wherein on the side of said mosaic screen which is scanned, insulating material projects beyond the exposed surfaces of said elements and wherein the photo-electrically-active screen which is

scanned by said light spot is placed in contact with said insulating material.

14. Cathode beam scanning means for a television camera, comprising an evacuated vessel containing a plate-like element having an extended surface capable of emitting electrons, a second thin plate-like element having a photo-emissive surface coating spaced from said first surface and parallel thereto, means for projecting an image of an object on said coating to cause emission of electrons therefrom and thereby place positive charges simultaneously upon different elemental areas respectively of said second element, whereby a free electron emitted from said first surface into said space will be attracted toward said second surface by said charges, said spacing being so small that when a bundle of electrons is emitted from any elemental area of said first surface they will pass to the geometrically opposite elemental area of said second surface without substantial spread, and means for causing electrons to be emitted into said space from said first surface element by element thereof in succession.

15. The combination with means for producing a beam of light moving along different parallel elemental paths in succession, of a separate unitary structure comprising a gas-tight container having an element therein for intercepting said moving light beam and thereby setting up a beam of electrons having a movement corresponding thereto, and a light sensitive electric element upon which said beam impinges, which element is coextensive with said first element and uniformly spaced a small distance therefrom.

16. An electro-optical apparatus comprising means for emitting electrons corresponding to radiations received from an object or field of view, means separated from said emitting means for storing said electrons, and means for scanning said storage means with a beam of light to cause a moving beam of electrons to be emitted therefrom.

17. An electro-optical transmitter comprising a screen of photo-emissive material and means adjacent said photo-emissive screen for generating a beam of low velocity electrons for scanning said screen, means for activating said screen with radiations controlled by an object or field of view, and means for producing a moving beam of light to control the operation of said first-mentioned means.

18. In a television transmission system wherein is included a scanning tube having therein a mosaic electrode of minute individually insulated particles upon which charges are adapted to be accumulated, and wherein is included also a photo-electrically responsive surface closely adjacent the mosaic, the method of operation which comprises the steps of illuminating the mosaic only with the light of an image to produce thereon an electrostatic charge replica of the image, scanning the photo-electrically responsive surface with a light beam to release photo-electrons therefrom at the points of scanning, directing the photo-electrons released to the mosaic to substantially neutralize the charges accumulated by the mosaic and return the individual elements of the mosaic to a predetermined datum level of charge, and energizing a load circuit in accordance with the charges released.

19. In an image transmitting tube provided with a photo-sensitive double-sided mosaic upon

which an optical image is to be directed and a photo-electric surface adjacent the mosaic, said photo-electric surface being adapted to be scanned by a light scanning beam, the steps in the method of generating signals representative of an image to be transmitted which comprise projecting the optical image upon one side of the mosaic to release electrons from the elemental areas thereof in accordance with the intensity of the light image projected thereon, collecting the electrons released from the mosaic by the projection of the optical image thereon, developing an electrostatic charge replica of

5 the image projected on the mosaic with the magnitude of the charges being proportional to the brilliance of elemental areas of the image, scanning the photo-electric surface with a light beam of substantially elemental cross sectional area to release photo-electrons, directing the released photo-electrons to the mosaic for reducing each elemental charge thereon sequentially to a substantially zero value, and energizing a load circuit under the control of the released charges.

HANS GERHARD LUBSZYNSKI.