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A. D. BLUMLEIN ET AL
TELEVISION TRANSMITTING SYSTEM

2,182,578

Filed Aug. 2, 1935

2 Sheets-Sheet. 1

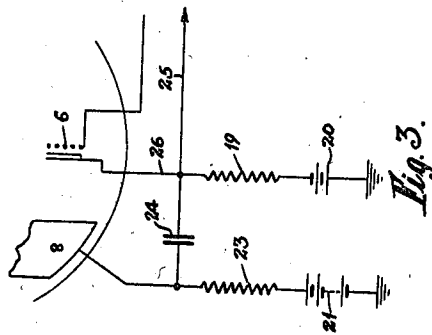
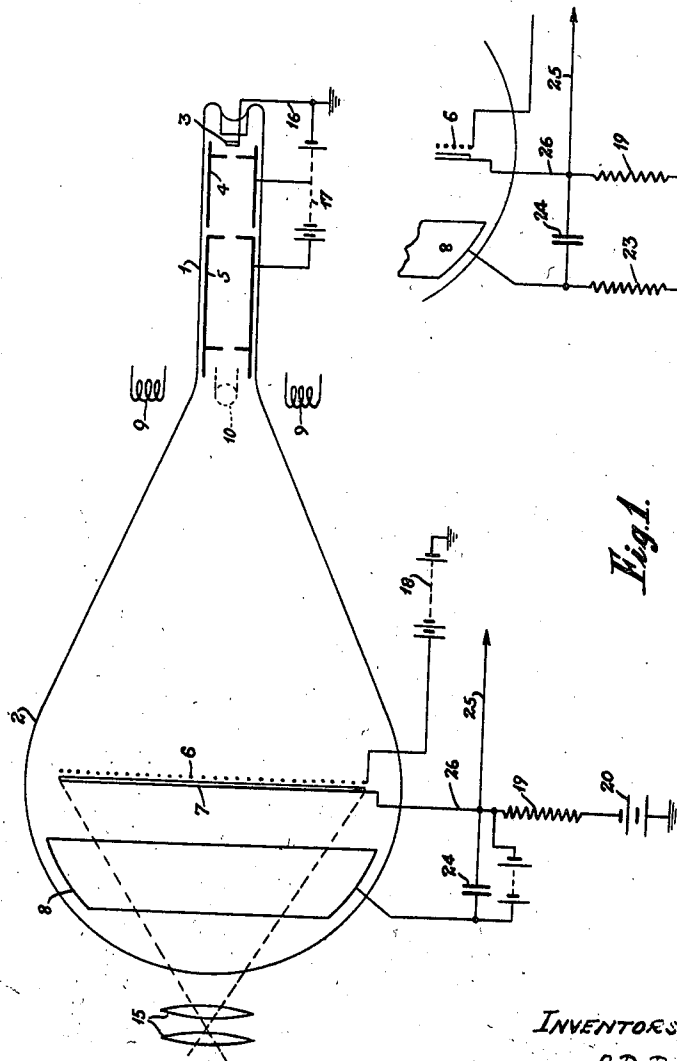
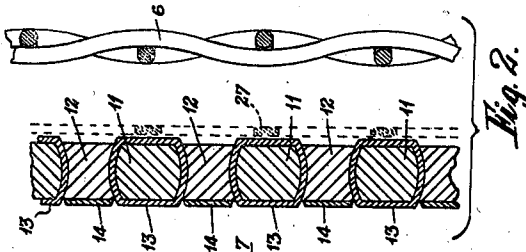


Fig. 1.

Fig. 3.

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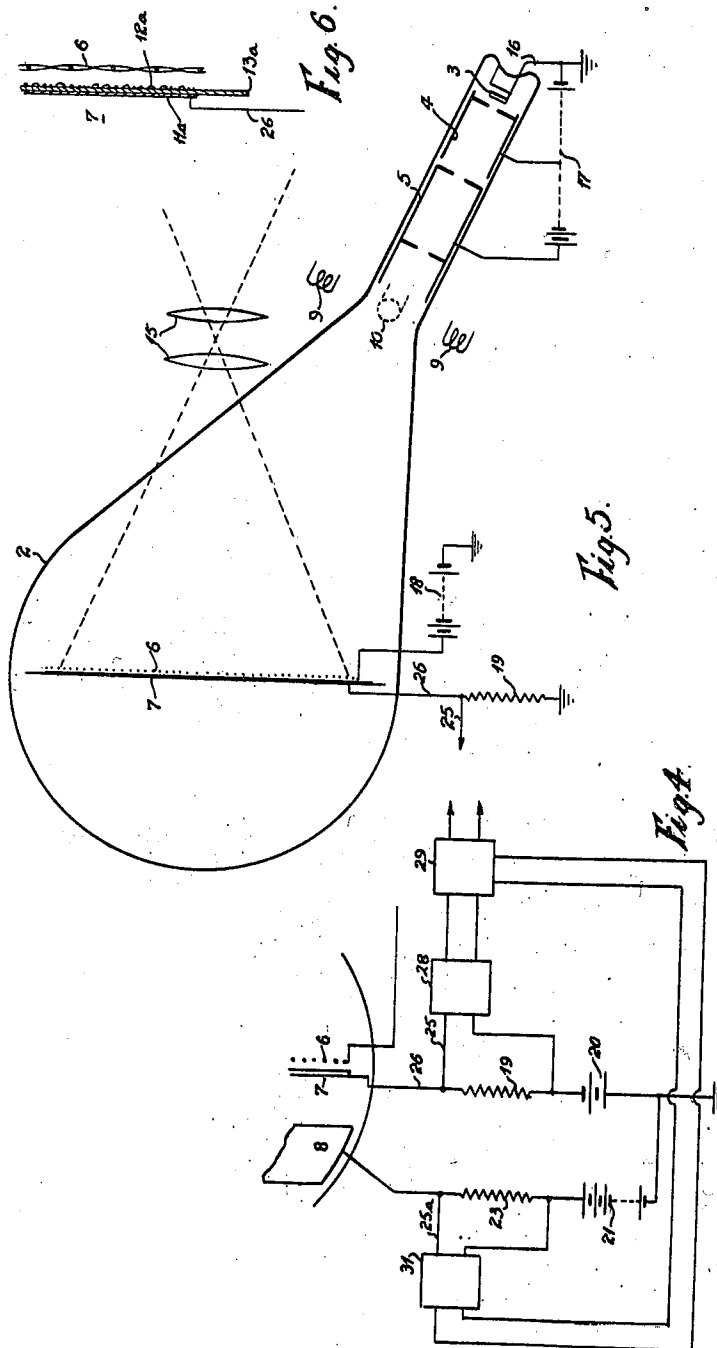
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UNITED STATES PATENT OFFICE

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TELEVISION TRANSMITTING SYSTEM

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9 Claims. (Cl. 178—7.2)

The present invention relates to television transmitting systems.

A television transmitting system is known in which an optical image of the object to be transmitted is projected upon a mosaic screen of photo-electrically active elements and the photo-electric surface of the screen is scanned by a cathode ray. The mosaic screen consists of a multiplicity of elements which are insulated from each other and from a common signal plate, each element forming, with the signal plate, a small condenser. Between successive scans, each elemental condenser acquires a charge determined by the number of photo-electrons emitted since the last scan, that is to say, a charge determined by the intensity of the light falling upon the element, and at each scan each elemental condenser is discharged. Picture signals are derived, in an external circuit associated with the common signal plate, from the electric impulses capacity-coupled to the signal plate. Such a system consists of the following essential features:

(a) A mosaic screen having a large number of small photo-electric elements, each element having capacity to a signal plate.

(b) Means for projecting an optical image of the object to be transmitted on to these elements.

(c) Means for collecting photo-electrons emitted by these elements, thus causing the capacities to be charged (or discharged) in accordance with the brightness of the images.

(d) Switching means such as a cathode ray or other electrical "switch" which periodically discharges (or charges) the condensers, bringing the photo-electric elements to a definite potential, the discharging (or charging) current so produced developing the required picture signals.

Two arrangements of the photo-electric elements are known. First the elements may be formed of small particles of metal insulated from a plate and lying on one side of the plate. In this case, the light is thrown on to the same side of the plate as that with which the cathode ray or electrical switch co-operates and such a plate may be called a "single sided mosaic screen". Secondly, the elements may be formed on a grid or open work plate from which they are insulated, or may be formed of rivets projecting through a plate from which they are insulated. The elements thus appear at both sides of the plate and it may be arranged that the light image is thrown on one side and the cathode ray or other "switch" operates on the other side. Used in this manner, the plate and elements may

be spoken of as a "double sided mosaic screen".

A television transmitting system employing a cathode ray tube having a single sided mosaic screen is described by Zworykin in the Journal of the Institution of Electrical Engineers of October 1933, page 437. In this system the optical image and the cathode ray operate on the same side of the mosaic screen. The cathode ray serves periodically to bring the potential of the mosaic elements to a few volts negative with respect to the potential of an anode. This potential difference causes the photo-electrons emitted by the mosaic elements to flow to the anode. With this device there are a number of difficulties which are caused by the fact that the collection of the photo-electrons depends on the effect of the ray, by the fluctuations of the signals caused by sudden changes of illumination, by the scattering of secondary electrons over the mosaic, by the irregular action of the ray at the end of scanning strokes, and the failure of the ray to discharge (or charge) the elements sufficiently fully.

Objects of the present invention are to effect improvements in the methods of operating apparatus which includes a mosaic screen of the single-sided kind or of the double-sided kind and improvements in the arrangement and construction of such apparatus.

Television transmitting apparatus has been proposed, as described in the specification of United States patent application Serial No. 19,752, filed May 4, 1935, which comprises an optical system for projecting an image of an object upon a photo-electrically active screen to cause emission of photo-electrons therefrom, a mosaic screen comprising mutually insulated elements or being in the form of a sheet having a high resistance in directions parallel to its surface, the mosaic screen being spaced apart from the photo-electrically active screen and being arranged with the mosaic screen within an evacuated envelope, focusing means for causing said photo-electrons to form an electron image upon the mosaic screen, means for developing a beam of electrons, means for causing this beam to scan the mosaic screen, and a signal plate capacitively associated with the mosaic screen. With this apparatus, also, difficulties may arise from the fluctuations of the signals caused by sudden changes of illumination, and it is a further object of the present invention to overcome these difficulties.

According to the present invention, a method of television transmission in which an optical

image of an object to be transmitted is projected upon a photo-electrically active mosaic screen, and the screen is scanned by electrical switching means which include a cathode supplying a beam of electrons, is characterized in that the switching means serve periodically to bring the potential of the elements of the mosaic screen to approximately the potential of the cathode.

According to the present invention in a further aspect, television transmitting apparatus comprising a mosaic screen of photo-electrically active elements insulated from one another and from a common signal plate, means for projecting an optical image of an object to be transmitted on to said screen to cause emission of photo-electrons from said elements, an anode adapted to receive said photo-electrons, electrical switching means for scanning said screen by a beam of electrons, and an impedance electrically connected with said signal plate and across which the picture signal voltages to be transmitted are developed, is characterized by a circuit arrangement between said anode and said signal plate such that impulsive changes in average brightness of said image do not produce corresponding impulsive changes in the voltage across said impedance.

According to the invention in another aspect, television transmitting apparatus comprises a photo-electrically active screen, means for projecting an image of an object to be transmitted upon said screen to liberate photo-electrons, an electrode for receiving said photo-electrons, either said screen or said electrode being of mosaic character and being arranged so that an electron image is formed thereon, means for scanning said mosaic to bring the potentials of the elements thereof to a datum value, a signal plate capacitively associated with said mosaic and, connected to said signal plate, an impedance across which picture signal voltages are developed when the mosaic is scanned, characterized in that a circuit arrangement is provided for mixing with the signal voltage from said impedance, before or after amplification thereof, a voltage which varies with the whole current due to said photo-electrons or with the alternating components of this current.

According to the invention in a further aspect, television transmitting apparatus comprises a photo-electrically active screen, means for projecting an image of an object to be transmitted upon said screen to liberate photo-electrons, an electrode for receiving said photo-electrons, either said screen or said electrode being of mosaic character and being arranged so that an electron image is formed thereon, means for scanning said mosaic to bring the potentials of the elements thereof to a datum value, a signal plate capacitively associated with said mosaic and, connected to said signal plate, an impedance across which picture signal voltages are developed when the mosaic is scanned, characterized in that there is provided a circuit whereby the current due to said photo-electrons, or at least the alternating components of this current are fed to a point between said signal plate and said impedance.

Where the mosaic screen comprises mutually insulated metal elements, the direct capacity between adjacent groups of these elements, each group constituting a "picture dot", is less than the capacity of each group to the signal plate, and it is preferably arranged that the total capacity of all the elements within the scanned

area to the signal plate is such that the time constant, defined by this total capacity multiplied by the effective resistance of the cathode ray of the switching means, is not greater than the period to be occupied by one complete scan of the whole area.

By "picture dot" is means an area representing one elementary dot on the transmitted picture. A picture dot is generally taken as a round or rectangular area equal in area to a square, the side of which is equal to the distance between adjacent scanning lines. Where scanning is effected with the aid of a cathode ray the area of the beam is made of the same order as that of one picture dot.

The mosaic screen may be composed of small rivets inserted in and insulated from a common metallic supporting plate which serves as the signal plate, and the surface of the rivets on one side may be made photo-electrically sensitive.

Apparatus according to the present invention preferably includes a multi-apertured plate disposed adjacent to the mosaic screen on the side thereof that is adapted to be scanned by the beam of electrons, and means for maintaining this plate at a potential positive with respect to the cathode which serves to supply the beam of electrons.

Henceforth, the multi-apertured plate will be called a "grid". The mosaic elements and the apertures in the grid may have different pitches and/or configurations, as for example a triangular spaced set of mosaic elements co-operating with a rectangularly spaced set of apertures in the grid.

The potential of the grid relative to the mosaic surface is made so positive as to produce a strong electrostatic field normal to the mosaic surface, thus preventing any appreciable travel of electrons in a direction parallel to the surface of the mosaic screen. Furthermore, where the grid is associated with a single-sided mosaic screen, the grid may serve to collect the photo-electric emission from the elements.

The invention will be further described with reference to the examples of parts of television transmission apparatus, shown in the accompanying diagrammatic drawings, in which similar parts in the different figures have the same reference numerals.

Fig. 1 shows a cathode ray tube having a mosaic screen of the double-sided type, with certain of the associated electrical circuits,

Fig. 2 is a section, to a greatly enlarged scale, of a portion of the mosaic screen in Fig. 1 and a grid adjacent thereto,

Figs. 3 and 4 show respectively two modifications of a part of the arrangement shown in Fig. 1,

Fig. 5 shows a cathode ray tube of the single-sided type, with certain of the associated electrical circuits, and

Fig. 6 is a section, to a greatly enlarged scale, of a portion of the mosaic screen shown in Fig. 5 and a grid adjacent thereto.

The apparatus shown in Figs. 1 and 2 comprises a cathode ray tube having an envelope in the form of a cylindrical portion 1 flaring out into a bulbous portion 2. Within the envelope are arranged in the order mentioned, and starting from the closed end of the cylindrical portion 1, a cathode 3 (the heating means for which are not shown), one or more electrodes, such as 4, which are adapted to take part in focusing the

ray, an anode 5, a grid 6, a mosaic screen 7 and an anode 8 which serves to collect photo-electrons. The cathode 3 and anode 5 may be of any suitable kind and between the anode 5 and grid 6 there are disposed either electrostatic or electro-magnetic means for deflecting the ray so as to scan the mosaic screen 7 upon which the ray is focused. In the present example these means have the form of deflecting coils 9 and 10.

The mosaic screen 7 is in the form of a metal "signal" plate 11, provided with regularly arranged perforations and disposed normally to the mean direction of the cathode ray. The signal plate 11 carries elements in the form of rivets 12 passing right through the perforations in the plate. The rivets are insulated from the plate, for example by coating the plate, before the insertion of the rivets, with a layer 13 of insulating material, and the ends of the rivets on the face of the plate opposite the face scanned by the cathode ray are coated with photo-electric material 14, such as caesium, the other ends of the rivets being uncoated.

The grid 6 is in the form of a plane, fine wire mesh disposed parallel to, and about 1 mm. from the mosaic screen, the cathode ray passing through this electrode on its way to the mosaic screen. The apertures in this grid should either register exactly with each mosaic element, so that each mosaic element has an aperture directly opposite, as shown in Fig. 2, or else the apertures of the grid should have no correspondence at all with the mosaic elements. In order to achieve this latter arrangement, it is convenient to arrange that the pitch of the apertures in the grid is entirely different from the pitch of the mosaic elements, or that the arrangement of the apertures in the grid and the mosaic elements is on a definite basis. For example, the mosaic elements may be arranged in triangular spacing, whereas the grid apertures may be arranged in a rectangular system as would be possible by using wire gauze. Alternatively, the mosaic may be formed of a very large number of small particles in random arrangement co-operating with a comparatively widely spaced set of apertures in the grid. It is desirable, however, that the pitch of the apertures in the grid be finer than the distance between adjacent picture dots.

The photo-electron anode 8 may consist of a metal coating on the glass wall, or it may be in the form of a wire or sheet metal electrode bent into rectangular or annular form. It is disposed at some distance from the mosaic screen in a plane parallel thereto.

A lens system 15 is provided, preferably outside the tube, as shown, for focusing an image of the object to be transmitted upon the photo-electrically active surfaces 14 of the elements 12 of the mosaic screen, light from the object passing through the central hole in the photo-electron anode 8.

The cathode of the tube is earthed by a conductor 16, the anode 5 is maintained at about 1000 volts positive with respect to the cathode by a source of potential difference 17 and the grid 6 is maintained at between 100 volts and 500 volts positive with respect to the cathode by a source of potential difference 18.

The signal plate 11 is connected by a conductor 26 to one terminal of a signal resistance 19 of 2000 ohms the other terminal of which is connected to the negative terminal of a four-volt source of current 20, the positive terminal of this source being earthed.

In order to ensure that the photo-electrons emitted by the mosaic elements 12 are all collected by the photo-electron anode 8, the negative end of a battery 21, of 200 volts, is connected to the terminal of the signal resistance 19 which is connected by the lead 26 to the signal plate 11, and the positive end of this battery is connected to the photo-electron anode 8. A decoupling condenser 24, the capacity of which is large in relation to the total capacity of the mosaic elements 12 to the signal plate 11, is also connected in shunt with the battery 21. The battery 21 must be well insulated from earth, and its capacity to earth must be kept low.

In order to operate the device, the various members are switched on in the following order: cathode 3 and deflecting means 9 and 10, anode 5 and focusing electrode 4, and finally the photo-electron anode 8.

During operation an image of the object to be transmitted is projected by the lens system 15 on to the face of the mosaic screen 7 and the back of the screen is scanned by the cathode ray.

Between the cathode 3 and anode 5, the cathode ray is accelerated to a velocity equivalent to 1000 volts, and, assuming for the moment that the parts of the mosaic screen 7 are at cathode potential, the ray is brought substantially to rest just as it reaches the mosaic screen.

Between successive scans, however, each element 12, owing to the emission of photo-electrons, acquires a positive potential proportional to the intensity of the light falling upon the element. Therefore when the ray is deflected on to a positively charged element, the latter attracts the electrons of the ray. At each scan of an element therefore, the element is charged negatively by the scanning ray until it reaches approximately cathode potential. This potential may differ slightly from the potential of the cathode due to the temperature velocity of the emitted electrons and contact potentials etc. At this stage the velocity of the ray is reduced to zero, so that an element cannot be charged negatively. The ray thus operates as a switch, reducing the potential of each element in turn almost instantaneously to zero. Furthermore, provided the elements are not charged too highly, the velocity of the ray on reaching the elements is at all times zero or very small, so that practically no secondary electrons are emitted from the uncoated faces of the elements.

The sudden changes of potential of the elements 12 are capacity fed to the insulated signal plate 11 and give rise to picture signals in the signal resistance 19. These signals are tapped at 25 and amplified and transmitted in any known or suitable manner.

This device may be regarded as operating in the following manner. When an optical image is formed on the mosaic screen, a photo-electric current, which is representative of the instantaneous average intensity of illumination of the screen, flows from the mosaic elements 12 to the photo-electron anode 8 and through the circuit 21, 26 to the signal plate 11. This may be regarded as the current charging the condensers formed by the mosaic elements and the signal plate, and it contains no picture signal component. Thus any impulsive components of the photo-electric current are sent back from the photo-electron anode to the signal plate, so that sudden changes of light, which are much quicker than the picture period, produce no impulsive potential changes across the signal resistance 19,

and the objectionable results of such transient changes are thereby eliminated.

When the cathode ray strikes a mosaic element which has acquired a positive charge owing to photo-emission, it lowers the potential of this element to substantially cathode potential, that is to say, it discharges the condenser formed by the element and the signal plate, and the signal thus capacity fed to the signal plate causes a flow of electrons to earth through the signal resistance, the number of the electrons being proportional to the charge previously acquired by the element. Thus the picture signal currents, due to successive discharge of the mosaic elements, are unidirectional and are accordingly representative of the absolute intensity of illumination of the individual mosaic elements. In this way, although transient variations of intensity of illumination do not adversely influence the transmitted signals, low-frequency changes of intensity of illumination are adequately transmitted.

The purpose of the grid 6 is two-fold. In the first place it serves to screen the ray, over the greater part of its flight, from the zero potential of the mosaic screen, and thus operates to preserve the focus of the ray. Secondly, the grid provides a strong potential gradient normal to the signal plate. When the ray approaches an element at cathode potential, it is turned back without striking the element. The strong potential gradient normal to the signal plate causes the electrons which have been stopped, to be accelerated back to the grid without any chance of their being pulled into elements of an adjacent dot which are at a positive potential. This strong field gradient thus prevents "fogging" of the signals.

It may in certain cases be desirable to provide an additional grid maintained at cathode potential and disposed between the grid 6 and the screen 7, for the purpose of suppressing any secondary emission that may arise from the mosaic elements 12. This additional grid, which is shown by dotted lines at 27 in Fig. 2, may be formed by a continuous mesh of electrically conducting material deposited on the insulating layer 13 of the signal plate 11.

The mosaic screen may be constructed in the following manner. A metal plate, about 0.15 mm. thick, is pierced with about 160,000 holes. These holes may be made by etching the plate (preferably from both sides) so that the holes are countersunk. Alternatively, the holes may be made mechanically. The holes may conveniently be 0.2 mm. in diameter and for a picture of 200 lines, four of such holes co-operate in forming what is referred to above as a picture dot. The plate is insulated all over by a thin layer of a suitable insulating material, such as glass, having a thickness of at least 0.2 mm. and the holes in the plate are then filled with metal rivets. These can be formed in position by plating through from one side of the plate to the other. The surfaces of these rivet elements are coated with silver on one side (for example by plating). The silver surfaces are then oxidised and activated with caesium to form photo-electric elements.

With such a construction, the direct capacity between adjacent elements is much smaller than the capacity of an element to the signal plate. Taking these dimensions and assuming a dielectric constant of 3 for the insulating material, the capacity per picture dot (four elements) is approximately 0.5 micro-microfarad. For a picture

consisting of 200 lines, each of 200 dots, making 40,000 dots to the complete picture, the total capacity of all elements to the signal plate is 20,000 micro-microfarads.

In order that moving pictures may be satisfactorily represented, it is necessary that the cathode ray shall be capable of discharging this total capacity substantially during a complete scanning cycle. By a complete cycle is meant a cycle during which the ray occupies all possible positions and such a cycle would include more than one "frame period" of a scanning cycle employing interlaced scanning. If for example the complete scanning cycle occupies a 25th of a second, it is necessary that the time constant of discharge of this capacity shall be less than a 25th of a second, i. e. the ray resistance should be such that the product of the ray resistance and 20,000 micro-microfarads will be less than $\frac{1}{25}$ second, that is to say, the ray resistance should be less than two megohms and preferably should not exceed one megohm.

This requirement of the product of the ray resistance and mosaic capacity can be looked at from another point of view. In the example given above, 40,000 picture dots were scanned in a 25th of a second, so that the ray rested on each picture dot for one millionth of a second. During this period it is necessary that the capacity of one picture dot viz. 0.5 micro-microfarads, shall be substantially discharged. Hence the product of the ray resistance and the dot capacity must be less than one millionth of a second, that is, the dot time. For the example taken, this again leads to a requirement of a ray resistance less than two megohms and preferably one megohm.

By ray resistance is meant the effective resistance of the cathode ray or other electrical switch looked upon as a switching resistance. If the elements of the mosaic depart from their datum voltage by a voltage V, and such voltage departure produces a re-stabilizing current equal to I, then the ray resistance is given by the ratio

$$\frac{V}{I}$$

The moment the ray hits the mosaic element, the voltage V is rapidly reduced, but for any value V of the mosaic element, a certain resultant number of electrons corresponding to the current I will be attracted by the elements. Suppose in the above example the mosaic elements were all short circuited to the signal plate, and the signal plate were held 10 volts more positive than the normal datum voltage of the mosaic elements (approximately cathode voltage), then a certain charging current would be obtained from the cathode ray. If this charging current were 10 microamps, then the average ray resistance over the range of 0 to 10 volts would be

$$\frac{10 \text{ volts}}{10 \text{ microamps}}$$

which is one megohm.

The light intensity falling on the mosaic elements must never be so great that a very large positive potential is developed on the elements during the period between successive scanings of the beam. If such a large potential is developed, the electrons hitting the mosaic elements will liberate secondary electrons, which may be more numerous than the primary electrons, and thus prevent the ray from restoring the mosaic elements to approximately cathode potential.

In the example shown in Fig. 1, it is desirable to limit the rise in voltage of the mosaic elements to between 5 and 20 volts positive with respect to the cathode ray cathode. Similarly, it is important that, during the process of switching on the tube, the elements should not attain a high positive potential. Suppose for example that before the cathode ray is switched on the photo-electron anode is energized and light falls on the mosaic, the elements will become positively charged to an abnormal extent, and not only will the ray when switched on be unable to restore them to cathode potential, but there is also a risk of breaking down the insulation of the elements to the signal plate. To prevent this, a suitable order of switching on the various potentials should be observed. For example, the cathode 3 and the current to the deflecting coils 9 and 10 may be switched on first. After that, the potentials are applied to the anode 5, then the grid 6 and finally the photo-electron anode 8.

The provision of the battery 20, which holds the signal plate 11 slightly negative relative to the cathode, ensures that any leakage in the insulation of the mosaic elements shall tend to hold these elements negative relative to the cathode, rather than allow them to drift to a dangerously high positive voltage. Similarly, this arrangement has the advantage that, if the insulation of any element to the signal plate breaks down, this element is held negative and becomes inoperative. This will cause a slightly darker spot on the received picture, whereas had the signal plate been positive, a very bright spot might have been produced.

The presence of the grid materially increases the capacity of the mosaic screen to earth. If the mosaic and grid are each 10 cm. square and are separated by 1 mm. as described above, the effective capacity of the signal plate to earth is of the order of 100 micro-microfarads. In order to reduce the abnormally high noise-to-signal ratio which would be produced by working this device into a single ordinary valve, the device may be worked into several valves in parallel, it being arranged that the input capacity of the valves equals the effective capacity of the device.

As an alternative, the grid may be more widely spaced from the mosaic screen, thus reducing the increase in capacity.

The grid must not be placed near enough, and its potential must not be high enough, to extract electrons from the mosaic screen. Also the tube must be highly evacuated in order to prevent trouble arising from the presence of ions.

In the modification shown in Fig. 3, the negative terminal of the battery 21, which maintains the photo-electron anode 8 at a suitable positive potential with respect to the signal plate and the cathode, is connected to earth instead of to the signal plate. The positive terminal of this battery is connected to the anode 8 through a resistance 23, while the condenser 24, as in Fig. 1, is connected between the anode 8 and the signal plate. With this modified arrangement, the alternating component of the current flowing to the photo-electron anode 8 is fed through the condenser 24 to a point in the lead 26 which connects the signal plate to the signal resistance. However, the direct component of this current in this case passes to earth through the resistance 23 and the battery 21.

In the modification shown in Fig. 4, the con-

denser 24 of Fig. 3 is omitted, with the result that the alternating component of the current due to the photo-electrons passes through the signal resistance 19. A voltage proportional to the photo-electron current is developed across the resistance 23. The changes in potential difference across this resistance are fed to an amplifier 31, while the picture signals are fed to an amplifier 28. The outputs from the amplifiers 31 and 28 are fed to a mixing device 29 so arranged that the component of the picture signal, due to the alternating component of the photo-electric current passing through the signal resistance 19, is neutralized by the output from the amplifier 31. Thus the signals developed in the mixer 15 output leads 30 are free from effects due to transient changes in intensity of illumination of the object being transmitted.

The devices shown in Figs. 1 to 4 employ a double sided mosaic screen, the mosaic elements of which are periodically restored to cathode potential. The advantage of neutralising the effects of transient changes of illumination, may be obtained with such a mosaic, even if the mosaic elements are periodically restored to some potential approximating to the potential of the anode of the device emitting the beam of electrons, in the manner described by Zworykin in the article referred to above.

Similarly the improved arrangement whereby the mosaic elements are periodically restored to cathode potential may be employed with a single-sided mosaic screen, as shown in Figs. 6 and 7. In this case the tube is similar to that shown in Fig. 1, except that the mosaic screen 7 is inclined to the electron gun 3, 4, 5 to allow the optical image to be thrown on the same side as that on which the cathode ray falls, and the lens system 15 is placed on the opposite side of the screen. No separate photo-electron anode is provided; the grid 6 acts as the photo-electron anode, since its potential is positive with respect to the maximum potential acquired by the mosaic elements. The wires of the grid 6 must be of extremely small diameter, since the image is projected through the grid. The mosaic screen 7 includes a mica sheet 13a (Fig. 6). On the side of this sheet facing the electron gun is formed a mosaic of separate silver elements 12a which are oxidised and photo-sensitized with caesium. On the opposite side of the mica sheet is a continuous silver signal plate 11a. In this arrangement it is desirable to limit to a low value the maximum potential to which the mosaic elements may rise, since the photo-active surface may emit secondary electrons at quite low voltage bombardment. Also it is desirable to make the mica sheet 13a comparatively thick in order to keep the capacity of the mosaic elements to the signal plate sufficiently low.

We claim:

1. Television transmitting apparatus comprising a mosaic screen which includes a signal plate and a multiplicity of photo-electrically active mosaic elements insulated from one another and from said signal plate, means for projecting an optical image of an object to be transmitted on to said screen to cause emission of photo-electrons from said elements, an anode for receiving said photo-electrons, electrical switching means for scanning said screen by a beam of electrons, an impedance electrically connected with said signal plate and across which the picture signal voltages to be transmitted are developed, and a circuit which connects said an-

ode to said signal plate and does not include any substantial part of said impedance.

2. Television transmitting apparatus comprising a photo-electrically-active screen electrode, means for projecting an image of an object to be transmitted upon said screen electrode to liberate photo-electrons, an electrode for receiving said photo-electrons, one of said electrodes being of mosaic character and being arranged so that an electron image is formed thereon, means for scanning said mosaic electrode to bring the potentials of different parts thereof successively to a datum value, a signal plate capacitively associated with said mosaic electrode, an impedance connected to said signal plate across which picture signal voltages are developed when said mosaic electrode is scanned, and a circuit for mixing with the signal voltage from said impedance a voltage which varies with at least the alternating components of the whole current due to said photo-electrons.

3. Television transmitting apparatus comprising a photo-electrically-active screen electrode, means for projecting an image of an object to be transmitted upon said screen electrode to liberate photo-electrons, an electrode for receiving said photo-electrons, one of said electrodes being of mosaic character and being arranged so that an electron image is formed thereon, means for scanning said mosaic electrode to bring the potentials of different parts thereof successively to a datum value, a signal plate capacitively associated with said mosaic electrode, an impedance connected to said signal plate across which picture signal voltages are developed when said mosaic electrode is scanned, and a circuit for feeding at least the alternating components of the current due to said photo-electrons to a point between said signal plate and said impedance.

4. Television transmitting apparatus comprising a mosaic screen having groups of mutually insulated photo-electrically-active mosaic elements, each group constituting a picture dot, a signal plate adjacent to and insulated from said elements, means for projecting on to said screen an optical image of an object to be transmitted, and electrical switching means which include a cathode for supplying a beam of electrons, means for periodically deflecting said beam over and thereby scanning said screen, the total capacity to said signal plate of all of the said mosaic elements within the area of said screen scanned by said beam is such that the time constant, defined by this total capacity multiplied by the effective resistance of said cathode beam, is not greater than the period to be occupied by one complete scan of said area, an electrode for receiving photo electrons from the photo-electrically active mosaic elements, an impedance electrically connected with said signal plate across which the picture signal voltages to be transmitted are developed, and means for connecting said electrode to said signal plate so that at least the alternating components of the whole current due to said photo electrons may be applied across said impedance.

5. Television transmitting apparatus comprising a mosaic screen having a signal plate and photo-electrically-active mosaic elements insulated from one another and from said signal plate, means for projecting on to said screen an optical image of an object to be transmitted, electrical switching means which include an electron gun having a cathode for producing a

beam of electrons and means for periodically deflecting said beam over and thereby scanning said screen, a grid disposed adjacent to said mosaic screen and on the side thereof that is adapted to be scanned by said switching means, and means for maintaining said grid at a potential positive with respect to the potential of said cathode, the apertures of the grid being arranged to register exactly in number and size with said mosaic elements.

6. Television transmitting apparatus comprising a mosaic screen having a signal plate and photo-electrically-active mosaic elements insulated from one another and from said signal plate, means for projecting on to said screen an optical image of an object to be transmitted, electrical switching means which include an electron gun having a cathode for producing a beam of electrons and means for periodically deflecting said beam over and thereby scanning said screen, and means for maintaining said signal plate at a potential which is slightly negative with respect to the potential of said cathode.

7. A television transmitting apparatus comprising a metallic signal plate provided with apertures, metal mosaic elements located in said apertures and insulated from said signal plate, the ends of said elements on one side of said plate being coated with photoelectrically active material and the other ends of said elements being relatively poor emitters of secondary electrons, means for projecting an optical image on to the side of said plate on which said photo-electrically active material is exposed, electrical switching means including a cathode for scanning the other ends of said elements with a beam of electrons, an anode for collecting photo-electrons emitted by said elements, a signal impedance, an electrical circuit including said impedance and said signal plate, and means to apply at least the alternating components of the current due to said photo-electrons to a point between said signal plate and said impedance.

8. A television transmitting apparatus comprising a mosaic screen having a signal plate and photo-electrically active mosaic elements insulated from one another and from the signal plate and cooperatively associated therewith, means for projecting onto said screen an optical image of an object to be transmitted, an electron gun structure including a cathode and an accelerating anode, means for maintaining said anode at a positive potential with respect to said cathode for producing a beam of electrons, means for periodically deflecting the beam of electrons over said screen to scan the elements thereof, an electrode positioned adjacent said mosaic screen and on the side thereof adjacent the gun structure, and means for maintaining said electrode at a positive potential with respect to the signal plate and the electron gun cathode and materially negative with respect to said accelerating anode, whereby the beam of electrons will be reduced to substantially zero velocity at the scanned surface of the mosaic screen.

9. A television transmitting apparatus comprising a cathode ray tube including a gun structure having a cathode and an accelerating anode, means for maintaining said anode at a positive potential with respect to said cathode to produce a beam of electrons, a mosaic screen in said tube, said screen including a signal plate and a plurality of discrete light responsive mosaic elements positioned in cooperative relationship with the signal plate, beam deflection

means for causing the beam of electrons to scan the light responsive elements of the mosaic screen, means to project an optical image of an object to be transmitted upon said screen to
5 produce a charge image on the individual elements, a grid electrode positioned adjacent the mosaic screen and on the side thereof that is scanned by the electron beam, means for maintaining the signal plate of the mosaic screen at
10 substantially the same potential as the cathode of the electron gun structure, and means for maintaining said grid electrode at a positive potential with respect to the signal plate and materially negative with respect to the potential of the accelerating anode, whereby the velocity of the beam of electrons will be reduced to substantially zero at the scanned surface of the mosaic screen. 5

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