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TELEVISION TRANSMITTING TUBE

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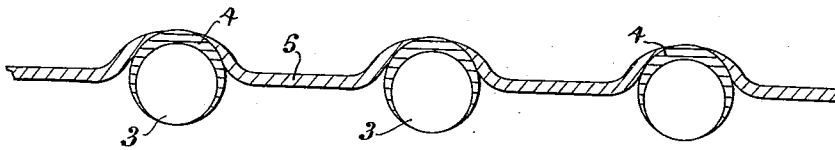


Fig. 1.

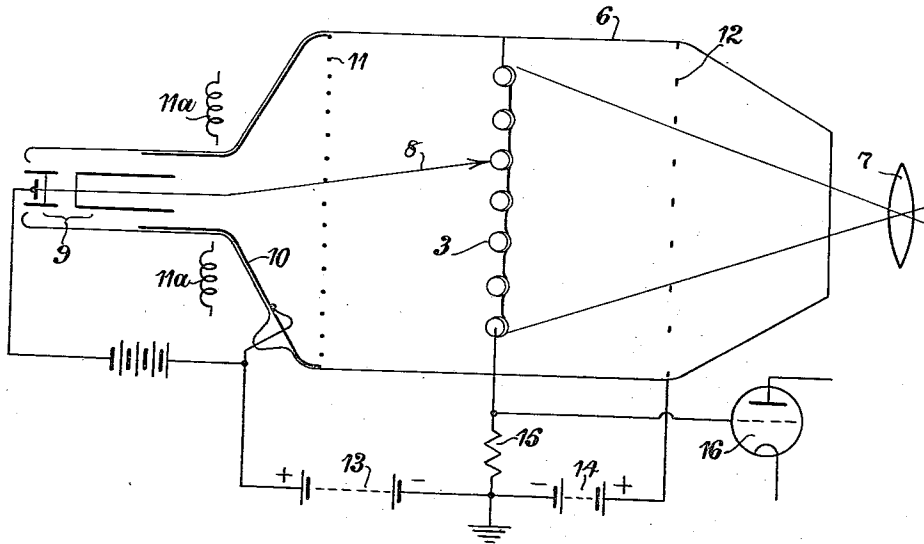


Fig. 2.

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TELEVISION TRANSMITTING TUBE

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3 Claims. (Cl. 250—150)

This invention relates to television transmitting systems of the kind which employ for the production of picture signals a transmitting tube having a mosaic screen of the so-called double-sided type.

In television transmitting tubes employing a mosaic screen of the single-sided type, an optical image of the subject for transmission is projected on to the photo-sensitive side of the mosaic screen which is composed of a multiplicity of mutually insulated elements capacitively associated with a signal plate. The projection of the optical image on to the sensitive elements causes an emission of photo-electrons whereby the elements of the screen acquire positive charges according to the intensity of elementary areas of the optical image. The mosaic screen is arranged to be scanned by a beam of electrons and on scanning, secondary electrons are liberated from the screen which restore the elements of the screen to a datum potential and generate in the signal plate picture signals for transmission. It is found with a tube of this kind that the secondary electrons released when the screen is scanned, tend to spread over the surface of the mosaic screen, which gives rise to the effect known as "tilt", tilt being manifested in a picture reproduced from signals derived from such a television transmitting tube in that the picture is unevenly shaded. For example, it frequently happens that the effect of tilt causes one corner of the reproduced picture to appear brighter than other parts of the picture. Much the same difficulty arises in television transmitting tubes of the kind in which an optical image is projected onto a photo-sensitive cathode, the photo-electrons released from the photo-cathode being accelerated and focussed onto a substantially non-photo-sensitive mosaic screen which is likewise scanned by a cathode ray beam. In other forms of television transmitting tubes it has been proposed to employ the so-called double-sided mosaic screen, such a screen being usually composed of an insulated wire mesh structure with conducting globules or rivets projecting into the interstices of the mesh, an optical image or a photo-electron image being projected into one side of the mosaic screen whilst the other side is scanned by a cathode ray beam. In such a type of tube owing to the spread of secondary electrons when the mosaic screen is scanned, tilt is also likely to occur. It is the object of the present invention to provide an improved television transmitting tube and method of operating such a tube, whereby tilt is reduced or substantially eliminated.

According to one feature of the invention an electron discharge device is provided for the generation of picture signals comprising a conducting grid-like structure having a plurality of mosaic elements covering the interstices of the grid-like structure and spaced from the latter by insulating material so as to be capacitatively associated therewith, the mosaic elements being so formed that on the projection of an image on one side thereof a charge image is stored by the double-sided mosaic screen formed by the grid-like structure and mosaic elements, means for scanning the side of the grid-like structure opposite the side on to which said image is projected, the side scanned being so formed as to be capable of releasing electrons as a result of the scanning operation, the scanning operation serving to restore the elements of the mosaic screen to a datum potential and means for collecting electrons released from the scanning operation, said grid-like structure being capable of being maintained at a negative potential with respect to said collecting means whereby a spread of electrons over the mosaic elements is reduced or substantially prevented.

The mosaic screen may be arranged to be scanned by a cathode ray beam or a light beam and it may also be constructed so that an optical or an electron image may be projected onto the mosaic screen. The collecting means may comprise an electrode which in operation is maintained at a positive potential with respect to the grid-like structure of the mosaic screen. In one form of operating a device in accordance with the invention secondary electrons or photo-electrons released on scanning the grid-like structure serve to restore positively-charged mosaic elements to a datum potential, whilst the residue of the secondary and photo-electrons released are drawn or saturated to the positively-charged collecting electrode. Since the grid-like structure of the mosaic screen will be at a negative potential with respect to the collecting electrode, the secondary or photo-electrons released from the grid-like structure, are prevented from spreading over the surface of the mosaic screen which thus substantially reduces tilt. In another form of the invention the mosaic screen may be arranged to be stabilised at its so-called second-cross-over point as hereinafter referred to.

In order that the said invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to the accompanying drawing in which:

Figure 1 is an enlarged cross-sectional view

of a double-sided mosaic screen for use in the invention, and

Figure 2 is a diagrammatic view of a television transmitting tube in accordance with one form of the invention employing the mosaic screen shown in Figure 1.

As shown in Figure 1 the mosaic screen comprises a conducting wire mesh 3, one side of the mesh being provided with an insulating layer 4 of enamel, or the insulating layer may be formed by evaporating a suitable material such as lithium borate or an alkali fluoride thereon. Between the interstices of the mesh, conducting elements 5 are provided. These elements may be applied to the insulated grid 3 initially in the form of a fairly thick conducting layer by floating the layer on the grid and then lapping or otherwise removing the portions of the layer lying on the insulated portions of the grid. The mosaic screen so formed thus comprises the conducting elements 5 which are mutually insulated from one another and from the mesh 3 by the insulation 4. The insulating layer 4 does not extend round the wires of the mesh so that the lower surface of the metal of the mesh as shown in Figure 1 is exposed, this surface being exposed to the scanning beam as hereinafter referred to. The mosaic screen so formed is mounted in an evacuated envelope 6 Figure 2 and the side of the mosaic screen to which the elements 5 are applied is rendered photo-sensitive so that on the projection of an optical image thereon through a suitable optical system 7, the photo-electrons are liberated causing the elements to become positively charged. The opposite surface of the mosaic screen is adapted to be scanned by a cathode ray beam indicated by the arrow 8 which is generated and focussed by an electron gun indicated generally by the reference numeral 9, the usual second anode 10 being provided to assist in the focussing action and to serve as a collecting electrode as hereinafter referred to. The cathode ray beam is deflected over the surface of the mosaic screen by suitable means such as coils 11a as shown, or by electrostatic deflecting plates not shown. If desired the second anode 10 may be connected to a grid structure 11 which assists in the collection of the secondary electrons liberated as the result of scanning the screen. For the purpose of collecting the photo-electrons liberated when an optical image is projected on the photo-sensitive side of the mosaic screen, a further collecting electrode 12 is provided, this electrode being shown as a grid structure but in some cases a ring electrode may be preferred. The second anode 10 and the collecting electrodes 11 and 12 are maintained at positive potentials by batteries 13 and 14 whilst the grid-like structure of the mosaic screen is maintained at a negative potential with respect to the collecting electrodes, and is connected through a resistance 15 to earth, signal potentials being generated on scanning the screen across the resistance 15 which are applied to a suitable amplifying arrangement indicated generally by a valve 16.

In an alternative arrangement instead of projecting an optical image on to the mosaic screen, an electron image may be projected thereon from a suitable photo-sensitive cathode, the side of the mosaic screen onto which the image is projected in such an arrangement being substantially non-photo-sensitive. The electron image may be projected on to the screen with such a velocity as to cause the release of a large num-

ber of secondary electrons leaving the mosaic screen positively charged. This arrangement may be similar to the discharge device described in British Patent Specification No. 442,666.

The potentials applied to the collecting electrodes 10, 11 and 12 are such that the electrode 12 serves to absorb substantially all of the photo-electrons liberated when an optical image is projected on to the screen, or to absorb substantially all of the secondary electrons liberated from the screen when an electron image is projected thereon. Likewise the electrodes 10 and 11 serve to collect the secondary electrons released on scanning the screen except the secondary electrons which are utilised to restore the elements of the screen to a datum potential as hereinafter referred to. In operation, assuming that the mosaic screen is not exposed to an image, then on scanning the screen by the beam 8, secondary electrons will be liberated from the wires 3 and the mosaic elements. The mosaic screen should be so formed that several elements are covered by the scanning electron beam. Under these circumstances an interchange of secondary electrons will occur between the grid wires and the mosaic elements so that ultimately each mosaic element after the scanning beam has passed it, is left at an equilibrium or datum potential with respect to the grid wires, such potential being determined by the geometrical structure of the screen, the relative secondary emission of the grid wires and the mosaic elements and the contact potential between the metal of the grid and that of the elements, and similar factors. Preferably the arrangement is such that the datum potential of the mosaic elements is substantially the same as the potential of the grid 3 so as to avoid any difficulties due to leakage as a result of faulty insulation.

On the projection of an image on to the mosaic screen, electrons are liberated which are collected by the electrode 12, the elements of the mosaic screen thus acquiring positive charges according to the intensity of elementary areas of the image. On scanning the mosaic screen secondary electrons will be liberated from the grid wires and from the mosaic elements and an interchange of electrons will occur until the mosaic elements 5 are restored to a datum potential which corresponds substantially to the potential of the grid wires 3. The capacity between the elements and the grid electrode 3 will be discharged by an excess of electrons passing from the grid to the mosaic elements which results in a decrease in the number of electrons which return to the collecting electrodes 10 and 11 and an increase in the electron current through the signal resistance to earth. Owing to the potential applied to the grid structure 3 the secondary electrons liberated on scanning can only pass from a mosaic element to the immediately surrounding grid wires and vice versa and any electrons escaping from the mosaic screen due to high initial velocities will enter the positive field generated by the collecting electrodes 10 and 11 and will thus be accelerated to and collected by the electrodes 10 and 11. Since the potential of the grid 3 is effective in preventing substantial spread of secondary electrons across the surface of the mosaic screen, tilt is substantially eliminated.

It may be possible to utilise the current flowing to the collecting electrodes 10 and 11 and the current flowing through the signal response 15 in a "push-pull" manner.

If desired, instead of scanning the mosaic screen with a cathode ray beam 8 the arrangement may be such that electrons are released from the grid-like structure 3 as a result of scanning with a light beam. With such an arrangement the surface of the grid-like structure 3 opposite to the side onto which the image is projected may be rendered photo-sensitive so as to release photo-electrons when scanned by the light beam. With such an arrangement it is desirable to avoid photo-emission as a result of the light scanning from the sides of the mosaic elements 5 facing the scanning beam and for this purpose the sides of such elements may be treated so that when the grid-like structure is rendered photo-sensitive, such as by the application of caesium, the sides of the mosaic elements facing the scanning beam are not rendered photo-sensitive. For this purpose the mosaic elements must be of a composite structure. Where the mosaic screen is formed in the manner above described a metallic layer may be first applied to the insulated grid-like structure, the said layer being of gold or other material which has very little affinity towards photo-sensitive materials. To the layer of gold a further layer of suitable material may be provided according to whether an optical or an electron image is to be projected onto the screen. With a device which is arranged to be scanned by a light beam the mosaic screen, together with the collecting electrodes 11 and 12 may be arranged in one evacuated container, whilst for the purpose of producing a light beam for scanning purposes a further cathode ray tube may be provided having at one end a screen adapted to be rendered luminescent under the impact of electrons and an electron gun is provided in the cathode ray tube for generating a beam of electrons which is caused to scan the screen causing the emission of light which is projected onto the photo-sensitive side of the grid-like structure opposite to that onto which the image is projected. The operation of the device is somewhat similar to that described above but instead of secondary electrons serving to restore the elements of the screen to a datum potential, the photo-electrons liberated on scanning the grid-like structure serve to restore the elements to the datum potential, the residue of the photo-electrons being collected by the electrode 11.

It may be found that in the operation of the transmitting tube as above described only blurred images of rapidly moving objects will result, but this disadvantage may be removed by employing a mechanical shutter in the optical system so that the image is only projected onto the mosaic screen during the frame return periods, that is to say, during the period when the scanning beam is returning to its initial position and after effecting a complete scanning operation of the mosaic screen. Alternatively the collecting electrode 12 may be maintained at the same potential as the grid 3 during the scanning period and then during the frame return period the electrode 12 is maintained at a strong positive potential. In this case no electrons will be drawn or saturated from the mosaic screen except during the short frame return periods. Such an arrangement might reduce the sensitivity of the mosaic screen but would effect an improvement in exposure time thus permitting rapidly moving objects to be resolved in a sharper manner.

If desired one or more stages of so-called electron or picture amplification may be associated

with the transmitting tube shown in the drawing. Where an electron image is projected on to the mosaic screen, one or more stages of multiplication may be associated with the device prior to the projection of the image on to a mosaic screen, or alternatively or in addition to such stages of multiplication the secondary electrons which return to the collecting electrodes 10 and 11 may be directed into one or more suitable electron amplifiers so that substantially noiseless amplification may be obtained before feeding the amplified signal into the first valve of the thermionic amplifier.

Where one or more stages of a picture multiplication are used it may be desirable in order to permit of the resolution of fast-moving objects, to reduce to zero or reverse the accelerating field which would be employed to accelerate the photo-electrons from the photo-cathode during the frame scanning period and then to restore the field to its required value during the frame return period so that the electron image is only projected on to the mosaic screen during the latter period. Preferably the reversal of the accelerating field is effected by applying suitable pulses to the appropriate electrodes, these pulses as nearly "square topped" as possible.

The transmitting tube described above may be employed either for the transmission of scenes directly or for the transmission of films. In the latter case either the image of each picture frame may be projected intermittently during the frame return periods or continuously in known manner, the former method however, being preferable since it will afford sharper pictures.

It is known that where an electron image is projected on to a mosaic screen the electron image suffers from various forms of distortion, the main distortion being due to a curvature of the electron image. For example, the centre of the electron image may be in focus whilst the outer portions of the image are out of focus. In the present case the curvature of the electron image may to a large extent be compensated by making the mosaic screen of concave form towards the incident electron phalanx. Thus by adjusting the curvature of the mosaic screen the electron image may be maintained in focus over substantially the whole area where it impinges on the mosaic. In such a case the mosaic screen would be convex towards the scanning beam so that the scanning beam would require to have a sufficient depth of focus to remain substantially in focus over the whole scanned area of the mosaic screen. If the pictures reproduced from a mosaic screen curved in this manner were found to suffer from "pincushion" or "barrel" distortion, such distortions could be corrected in known manners.

For the purpose of forming a curved mosaic screen a flat metal mesh may be first embedded in a ductile metal or other plate which is then pressed to the shape required. After annealing the metal mesh the metal plate may be removed as for example by dissolving by any suitable acid or other solvent leaving the mesh curved as required. If it is found that the curvature required for the mosaic screen should be of a non-spherical shape in order to fit the curvature of the electron image, such shape can be readily imparted to the mosaic screen. After pressing the mesh to the required shape the mosaic screen may be formed thereon as described above a complementary curved supporting plate being used to

prevent distortion of the mesh during formation of the mosaic screen.

In an alternative form of the invention the side of the mosaic screen which is scanned by a cathode ray beam may be so constructed that very few secondary electrons are liberated when the scanning beam impinges on the mosaic elements and the charges which are accumulated on the mosaic elements when an image is projected thereon cause a variation in the emission of secondary electrons generated on scanning the grid-like structure of the mosaic screen. The mosaic elements are restored to a datum potential not by virtue of the secondary emission but as a result of the collection of primary electrons from the scanning beam. In this form of the invention the mosaic structure may be substantially the same as that described with reference to Figures 1 and 2 with the exception that the surface of the mosaic elements 5 facing the scanning beam are provided with a coating of low secondary emissive properties. For example the side of the said elements facing the scanning beam may be coated with carbon or similar material. On the projection of an optical or electron image on to the other side of the screen the elements of the mosaic become positively charged according to the intensity of the incident image. The velocity of the scanning beam is preferably so arranged that the elements of the mosaic screen stabilise substantially at what is known as the "second-cross-over point" see British Patent Specification No. 475,928. If a curve is plotted indicating the ratio of the number of secondary electrons emitted by a substance to the number of primary electrons incident on that substance as ordinates and the velocity of the incident primary electrons as abscissae, the velocity being expressed as a voltage difference between the series of primary electrons and the substance, it will be found that from zero the curve rises to the point where the ratio of the secondary electrons to the primary electrons is unity, continues to rise as the voltage difference increases to the peak value where the ratio of the secondary electrons to the primary electrons reaches its maximum value greater than unity, the curve then falling with increasing voltage differences to a point where the ratio is again unity and continues to fall below this point where the ratio is less than unity. The point on the curve where the ratio is unity is referred to as the "first cross-over point" and the second point where the ratio is again unity is referred to as the "second cross-over point." The elements of the mosaic screen as stated above are preferably arranged so that owing to the velocity of the scanning beam the elements stabilise at their second cross-over point when no image is projected thereon. The potentials applied to other electrodes in the tube are so arranged that at the second cross-over potential the elements of the screen are so negative with respect to the potential of the grid-like structure of the mosaic screen that only very few of the secondary electrons released when the grid-like structure is scanned, are able to reach the collecting electrodes 10, 11. When an image is projected into the mosaic screen the elements become positively charged, as stated above, according to the intensity of the image and since the potentials of the elements are thereby raised more secondary electrons are permitted to escape from the grid-like structure to be collected by the collecting electrodes. The mosaic elements therefore act in a manner similar to an elementary control grid

permitting a larger or smaller number of secondary electrons to be liberated from the grid-like structure according to the potentials of the elements. When the scanning beam impinges on the mosaic elements the latter will be driven to more negative values closely approximating to the second cross-over point. The required picture signals may be established across a signal resistance connected in series with the collecting electrodes 10, 11. Owing to the high negative potential of the mosaic elements substantially no spread of secondary electrons over the surface of the mosaic will occur.

We claim:

1. An electron discharge device for the generation of picture signals comprising an evacuated housing, a double-sided mosaic screen positioned in said housing including a conducting grid-like structure, insulating material covering substantially all of the grid-like structure with portions of the grid-like structure extending through the insulating material along one side of the structure, a plurality of individual conducting elements located in the interstices of the grid-like structure and supported by the insulated material in order that the elements may be capacitively associated with said structure, a light responsive coating on the side of each of the individual elements opposite the said one side of the structure whereby a charge image is stored on the double-sided mosaic screen when a light image is projected thereon, means for scanning the portions of the grid-like structure that extend through the insulating material, the scanned portions of the structure being adapted to release secondary electrons as a result of the scanning operation, the scanning operation serving to restore the elements of the mosaic screen to a predetermined datum potential, electrode means for collecting the secondary electrons released from the scanned side of the mosaic, and means for maintaining the grid-like structure at a negative potential with respect to said collecting electrode means whereby the spread of electrons over the individual elements is reduced or substantially prevented.
2. An electron discharge device for the generation of picture signals comprising an evacuated housing, a double-sided mosaic screen positioned in said housing including a conducting grid-like structure, insulating material covering substantially all of the grid-like structure with portions of the grid-like structure extending through the insulating material along one side of the structure, a plurality of individual conducting elements located in the interstices of the grid-like structure and supported by the insulating material in order that the elements may be capacitively associated with said structure, a light responsive coating on one side of each of the individual elements whereby a charge image is stored on the double-sided mosaic screen when a light image is projected thereon, means for scanning the portions of the grid-like structure that extend through the insulating material, the scanned portions of the structure being adapted to release secondary electrons as a result of the scanning operation, the electrons of the scanning beam operating to restore the individual elements of the mosaic screen to a predetermined datum potential level, electrode means positioned on the scanned side of the mosaic screen for collecting the secondary electrons released from the scanned side and means for maintaining said electrode means positive with respect to said mosaic screen

whereby a dispersion of secondary electrons over the individual elements is substantially prevented.

3. An electron discharge device according to claim 1 wherein additional electrode means are provided for collecting the released photoelec-

trons as a result of the projection of the light image on the individual elements, and means for maintaining said additional electrode means positive with respect to said grid-like structure.

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