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TELEVISION TRANSMITTER

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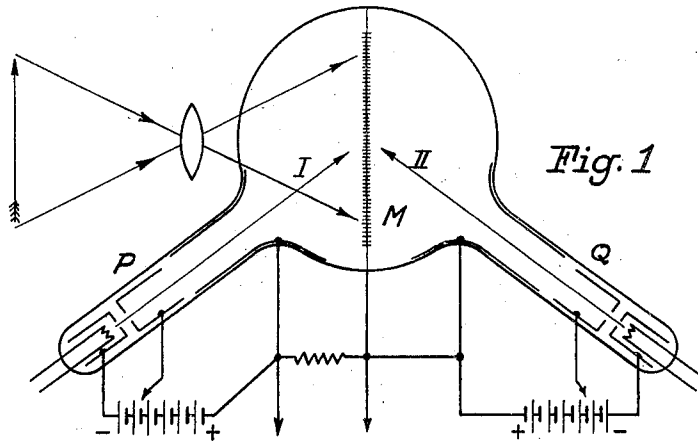


Fig. 1

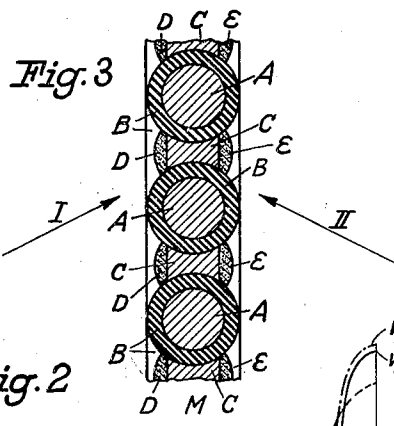


Fig. 3

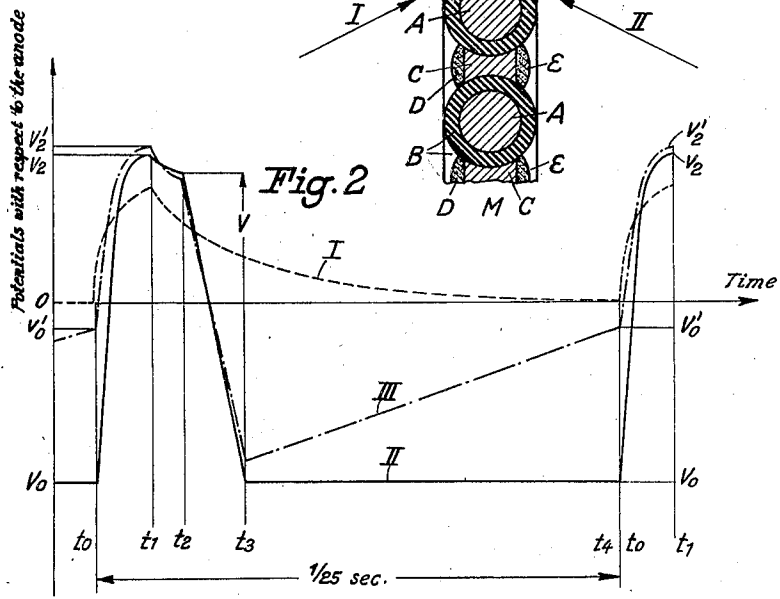


Fig. 2

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TELEVISION TRANSMITTER

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The invention relates to television transmitters of the kind in which an image of the object to be televised is analysed or scanned by a cathode beam moved across it in a series of parallel paths. The object to be televised is either projected directly onto a screen which has light-sensitive elements arranged to store electric charges, or is projected on a semi-transparent photocathode to produce an optic image thereon while the photo-electrons, emanating from this cathode in accordance with the luminosity values of the image, are in their turn reproduced on the light-sensitive screen in electron-optic fashion. The cathode beam used for scanning acts to restore the light-sensitive elements of the screen to an equilibrium potential, these elements being well insulated from each other and from the so-called signal plate that forms part of the screen. Television transmitters of this kind enable the charges originating on the screen either by the light itself or by the electrons impinging upon the screen, to be partially stored during a scanning period. However, the efficiency of these devices is comparatively small since only 5 or 10% of the emission of electrons from the mosaic, produced thereon by the light or by the photo-electrons, are available for the electrostatic picture. This small utilisation is due to the working conditions of the television transmitters. In fact, as is well known, a space charge arises between mosaic and accelerating electrode through the electron bombardment effected by the scanning beam. Such space charge on the one hand aids in scanning and therefore is necessary with signal storing cathode ray scanning tubes. On the other hand, however, the space charge also aids in producing the electrostatic image and, hence, entails the said low efficiency, because the emission of photo-electron or the adequate emission of secondary electrons is completely compensated during a part of the scanning period. This will be understood from the following.

All the potentials finally acquired by the mosaic elements during scanning as well as afterwards are equilibrium values, that is, values with which as many electrons return to the emanating mosaic element, and from the space charge in front of the mosaic, as are leaving such element, there being in this way an outgoing stream and a reverse stream which equals the former. As is well known, the positive electrostatic picture or, more particularly, the picture potential difference $V_1 - V_1$ between an illuminated element and a non-illuminated one is due

to a complicated reaction effect between space charge and the emission of electrons. When owing to the space charge the elemental capacities of the mosaic screen have been charged to an equilibrium potential of say +3 volts with respect to the accelerating electrode or anode, a stream of electrons returns to them and acts to discharge them to an extent that depends on the space charge. A non-illuminated element, emitting no electrons, after scanning finally acquires the potential V_1 which is such that this element ceases from receiving electrons from the space charge. Elements, however, which are illuminated and, hence, emit a stream of photo-electrons which is proportional to their potentials, are discharged to potentials V_1' which are more highly positive than V_1 and with which, as stated, the reverse stream from the space charge will be just equal to said outgoing stream. As these equilibrium values are reached after a fraction of one scanning period, the photo-emission will not affect the potential difference $V_1' - V_1$ during the remaining time. Furthermore, this emission merely serves to maintain such potential but does not increase it since the mosaic element receives from the space charge the same number of electrons as are added to the space charge. In this way, a positive electrostatic image which is adequate to the luminosity values of the picture is produced on the screen. However, the photo-emission is utilized here in part only. Experience has shown it to be utilized to about 5 or 10% only. This drawback, which is mainly due to the cause just referred to, is attributable also to the extremely unsuitable provisions for accelerating the photo-electrons, because the potential of the mosaic is in close neighbourhood of the potential of the accelerating electrode and the space charge is always in the nature of a negative potential wall formed in front of the mosaic. Under such conditions, photo-electrons are not directly transferred to the anode but are transmitted to the space charge. As a result, only the said fraction of photo-electrons is rendered available for the electrostatic image.

An improvement would be to apply to the mosaic a suitable negative bias, the acceleration, acting on the photo and secondary electrons, being improved thereby. Such bias should be calculated to provide for a certain space charge, namely, the space charge necessary for the scanning operation and which therefore must be below the saturation voltage of the secondary electrons liberated by the scanning beam.

In order to bias the mosaic elements nega-

tively with respect to the accelerating electrode they require to be supplied with a negative charge in any suitable manner. An obvious expedient will be to supply the electrons by the intermediary of the signal plate which to such end is given a negative potential with respect to the anode, and to replace the customary mica insulation of the mosaic screen by a suitable semiconductor. In the case of screens so provided with a semi-conductive dielectric the photo-electric charge originates on a layer possessed of a finite time constant which is about 5 times the scanning period. Since all of the photo-electric potentials and signals are generated at this transmission member, each potential due to a signal will in all probability attain its final value not at once but during a number of scanning periods. Therefore, disturbances can arise when transmitting a picture of rapidly changing contents. This also accords with the fact, found by experiment, that a moving object appears to show less contrasts than an object which is at a standstill, and that an object which is first at a standstill and is then quickly moved out of the range of vision causes after-images to be seen. It seems that these disturbances can be obviated to a great extent by choosing the working conditions accordingly. Although the sensitivity is diminished in this way yet screens of the semiconductor type appear to be more sensitive than the iconoscope by Zworykin.

The invention described hereafter not only allows of utilizing the photo-emission to an extent greater than in the case of the iconoscope and greater also than in the case of semiconductor screens. In addition, avoiding the use of a semiconductor is of advantage inasmuch as certain disturbances which may be caused by a device of this kind will be obviated. In accordance with the gist of the invention the space charge in front of the mosaic must be permitted to arise to such extent only as will be necessary for the scanning operation, whereas the invention aims to preclude the detrimental influence by which the space charge tends to affect the electrostatic image. For this purpose a suitable negative bias is applied to the mosaic.

In order to achieve this, cathode ray scanning devices as provided by the invention operate with the aid of two cathode beams instead of only one. These beams arrive in opposite directions and are moved in synchronism over a screen capable of storing electric charges, one beam having to scan the mosaic elements while the other has to bias them negatively.

When employing a scanning process of the kind known from the iconoscope while providing for high light-sensitivity of the mosaic elements, there should be a secondary emission factor of the value $S > 1$, whereas for the negative charge to be produced by the second beam a secondary emission factor $S < 1$ is necessary. The invention therefore requires each mosaic element to be possessed of both these properties. Under the invention each mosaic element is arranged to project through the screen, thus being accessible from both sides thereof. However, the mosaic elements so arranged are not on both sides of high photo-electric sensitivity but are so on that side only on which picture projection and scanning are effected. On this side and with the proper rate of moving the beam the secondary emission factor is > 1 . On the other side, the mosaic elements are provided with a substance having a secondary emission factor

< 1 . In this way, it is possible for the second or charging beam to supply the mosaic elements with a predetermined quantity of negative electricity and thereby to apply to it the proper negative bias. The charging beam is somewhat out of phase with the scanning beam but is moved with the same velocity as this.

The invention is thus characterized by the use of a two-side mosaic to which the said special properties are peculiar, combined with two cathode beams one of which scans the positive electrostatic image while the other, acting on the opposite side of the screen, creates the negative bias.

In the accompanying drawing, Fig. 1 is a diagrammatic sectional view showing one embodiment of the invention, Fig. 2 is a graphic representation that serves to explain the function of arrangements as provided by the invention, Fig. 3 is a sectional detail, drawn to a larger scale than Fig. 1 and illustrating a constructional form of the screen which in Fig. 1 is represented schematically.

In Fig. 1, I denotes the scanning beam, II the charging beam, while M indicates the two-side mosaic screen. P, Q designate scanning devices which are well-known per se and include so-called electron guns for generating the beams I, II.

As shown in Fig. 3, screen M comprises a fine-meshed metal grating A which is equivalent to the well-known signal plate of the customary single-side mosaic screen. Grating A is provided with an insulating coating B and the apertures of the structure A, B are filled with a suitable metal C, as silver, for example. Screen M thus comprises small capacities A, B, C. On the side facing the beam I each metal core C is covered with highly sensitive photoelectric material D of a secondary emission factor $S > 1$, whereas on the other side the cores C are coated with material E to which a secondary emission factor $S < 1$ is peculiar. For instance, carbon or aquadag will be suitable for this purpose. Scanning and picture projection are effected both on the same side of the screen M. The object to be televised is projected either directly onto the screen, as shown in Fig. 1, or onto a semi-transparent photo-cathode. The emission of photo-electrons from such photo-cathode, and which is adequate to the optic image, is in electron-optic fashion reproduced on the screen and is stored there.

The operation of the novel device will be obvious from the variation which the potential of a non-illuminated element as compared with an illuminated element undergoes during a scanning period in the manner represented by the curves II and II', Fig. 2. For simplicity, we will for the first assume that only the scanning beam is moved over the non-illuminated element. This case is identical with the customary form of the iconoscope. Curve I shows the potential variation which a non-illuminated element undergoes. During scanning an equilibrium potential arises at the instant of time t_1 . Thereupon a recharging to a new equilibrium potential occurs. Depending upon the intensity of the beam and the relative space charge conditions this novel equilibrium potential may assume values which are higher or lower than the anode potential or are equal to it. In Fig. 2, such equilibrium potential is shown to coincide with the anode potential.

When now in addition to the scanning beam I

also the charging beam II is moved across screen M with the same velocity as beam I but with a slight phase shift with respect to it, then a non-illuminated element will undergo a potential variation of the kind represented by curve II, as will be understood from the following consideration. As each mosaic element has a secondary emission factor $S < 1$ at the end facing the beam II, each element is supplied with an electric charge $E = (S - 1) i_{II} T_0$ after beam I has left it. i_{II} is the intensity of the beam II while T_0 is the scanning duration. The potential of the respective element is thereby decreased from the value it has when beam II impinges upon it at the instant t_2 . Such potential is in this way decreased by an amount

$$V = \frac{E}{C}$$

volts during the duration T_0 , this being the time interval $t_2 - t_3$. C here is the capacity of an element whose area is defined by the cross sectional area of the beam. As the potential decrease V can be predetermined by choosing the intensity of the beam II accordingly, the potential may be given a suitable negative value V_0 with respect to the anode. In this way it is possible for the mosaic to be biased negatively. This bias causes the space charge to be less than in the case of the ordinary iconoscope, the negatively biased element thus being substantially protected against the influence of electrons from the space charge. A non-illuminated element, after beam II has left it, hence continues to be of the potential V_0 until touched by beam I at the instant t_4 or t_0 . Beam I owing to the relation $S > 1$ raises the potential V_0 . Through this charging operation the element under consideration is restored into the state where it can be acted upon by the space charge. The space charge hence causes an equilibrium potential V_2 to be attained by the element. Compared with an iconoscope not biased, the intensity of beam I, however, being the same, the peak equilibrium potential V_2 is at that moment of a somewhat higher voltage, since the space charge has been reduced. If now at the instant t_1 the beam I leaves the element the equilibrium is undone; the electrons returning from the space charge decrease the potential until instant t_2 is reached, and the described operation recurs. It is of importance that the peak equilibrium potential which arises at the instant t_1 is in the nature of an equilibrium state, whereas such is not the case with potential V_0 created by beam II, because potential V_0 is below the value to which it might be recharged by the available space charge alone. There must hence be a certain voltage range from the initial value V_0 onward to more highly positive potentials in which the element is practically not affected by electrons from the space charge, that is to say, under the prevailing circumstances the photo-emission will be effectually conveyed to the anode and the resultant charging of the elements will not be greatly decreased or compensated by electrons from the space charge.

As regards an illuminated element, emitting a stream of photo-electrons which is proportional to the degree of illumination, the potential variation during a scanning period will be of the kind represented by curve III. Due to the photo-emission the peak equilibrium potential V_2 at instant t_1 is somewhat higher than with a non-illuminated element, as is the case also with the ordinary iconoscope. As soon as beam I leaves the element at instant t_1 , thus doing away

with the state of equilibrium, the retroaction between photo-emission and space charge causes the potential to decrease until the instant t_2 is reached, at which the beam II begins to affect it. Beam II in its turn decreases the potential during the period of sweeping the element. On account of the photo-emission the potential thereof will not entirely coincide with the value V_0 . The element, negatively biased after the beam II has left it, will then readily deliver its photo-emission to the anode. The potential of this element therefore rises and the instant t_4 reaches the value V_0 . Beam I at this moment touches the element and thereby acts to reduce it to an equilibrium potential, whereupon the described operation recurs. As the peak equilibrium potentials in the case of illuminated and non-illuminated elements are approximately the same, the difference $V_0' - V_1$ is the effective picture potential difference that varies in accordance with the intensities of brightness and which during the scanning operation produces an adequate drop of potential across the coupling resistance, this drop of potential being utilized in well-known manner.

It can be seen that the sensitivity of the arrangement is not only greater than that of the iconoscope but greater also than the sensitivity of semi-conductor screens.

The sensitivity of the described arrangement may be increased by means of a secondary emission amplifier associated with the mosaic screen, the increase so obtained being about 10 times the original value. To such end the optic image of the object to be televised is not produced on the screen but is produced on a semi-transparent photo-cathode. The photo-emission from this cathode, and which is adequate in its cross sectional intensities to the optic image, is in electron-optical fashion reproduced on the screen. The increase in efficiency is on the one hand due to the fact that the semi-transparent layer is about 3 times more highly sensitive to photo-electrons than is the mosaic, while on the other hand such increase is attributable to the amplification to which the photo-electrons impinging upon the screen are subjected by the secondary electrons generated by them and which is about 5 times the original number of electrons. The negative bias applied to the charge-storing mosaic renders it possible readily to accelerate the electronic emission produced on the screen, such being the case with both optic and electron-optic reproduction, and to store the electrostatic charges so generated at the respective spots of the screen. The invention thus involves a considerable advance as regards the efficiency of charge-storing television transmitters.

What is claimed is:

1. A cathode ray scanning device comprising a screen comprising a plurality of mutually insulated conductors mounted adjacent each other, the ends of said conductors forming two opposite surfaces, a coating of photo-sensitive material on the ends of said conductors forming one of said surfaces, said material having a secondary emission factor greater than unity, and a coating of material having a secondary emission factor less than unity on the ends of said conductors forming the other of said surfaces, means for generating a first electron beam, means for directing said beam on to said one of said surfaces, means for deflecting said beam to scan said surface at a predetermined rate, means for generating a second electron beam, means for

directing said second beam on to the other of said surfaces, means for deflecting said second beam to scan said other surface at said predetermined rate, said second beam being delayed in phase with respect to said first beam, and means for projecting a light image on said surface scanned by said first beam.

2. A device according to claim 1, wherein said screen is composed of a metal grating, insulating material with which this grating is coated 10

in a manner to present apertures lined with insulating material, metal cores held in place by these apertures and reaching from one side of the screen to the other, photo-electrically sensitive material covering those ends of said cores which are located on one side of the screen, and material having a secondary emission factor >1 covering the other ends thereof.

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