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TELEVISION AND THE LIKE SYSTEMS

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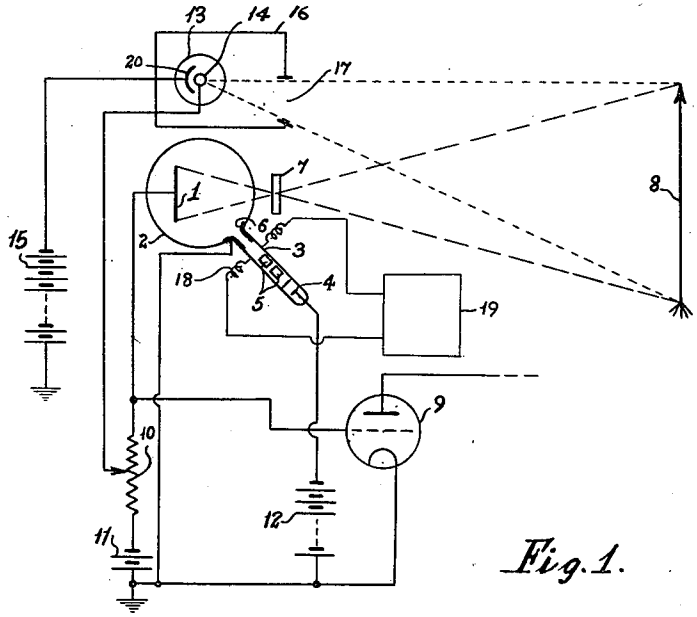


Fig. 1.

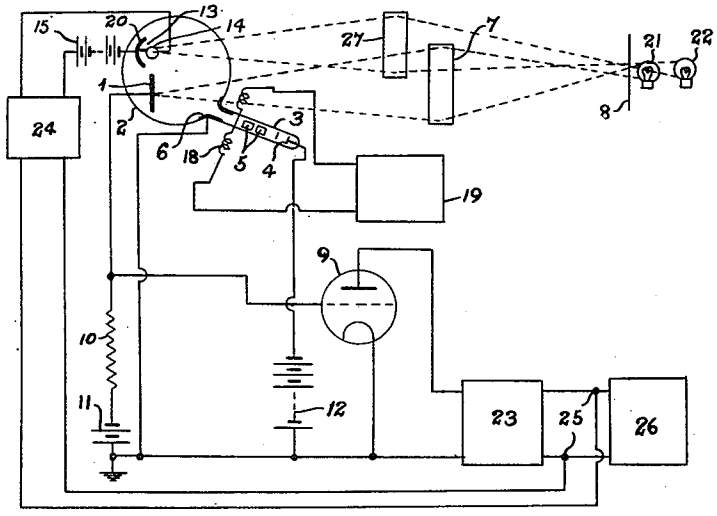


Fig. 2.

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TELEVISION AND THE LIKE SYSTEMS

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5 Claims. (Cl. 178—7.2)

The present invention relates to television and the like systems and more particularly to systems employing for transmitting purposes a cathode ray tube provided with a "mosaic" screen.

In one form of tube of this kind, an image to be transmitted is projected on to a "mosaic" of small photo-electric elements insulated from one another and from a conducting back-plate upon which they are carried. The elements are usually deposited upon an insulating layer provided on the back-plate which will be referred to as the signal plate.

Within the tube are provided, in addition to the mosaic screen, a source of electrons, means for directing the electrons in a narrow beam upon the screen, an anode for collecting electrons emitted by the screen and deflecting means for causing the electron beam to scan the screen.

The deflecting means may be in the known form of coils or electrostatic plates which when supplied with electrical oscillations of saw-tooth wave form cause the ray to scan the screen in parallel strips, each scanning stroke being followed by a return stroke.

When the image is cast upon the screen, each element of the "mosaic" emits electrons, and accordingly rises in potential, in proportion to the brightness of its illumination and these electrons pass to the anode. What can be regarded as an electron image is thus formed on the "mosaic" by the electric charges on the elements thereof. When the cathode ray passes over an element during the scanning operation, the charge thereon is neutralized thus bringing the element to a datum potential which is negative with respect to the anode potential. When the ray leaves the element the potential of the element again rises due to the emission of photo-electrons to the anode. The neutralizing charge given to each element by the cathode ray when it passes over the element is therefore dependent upon the amount of photo-electric discharge that has taken place.

If a resistance be arranged in series between the signal plate and the anode of the device above described, there are developed across the resistance potential pulses which are representative of the brightness of illumination of the successively scanned elements of the "mosaic".

So long as the average illumination of the "mosaic" screen remains constant, the average current flowing to the signal plate is zero. When the cathode ray scans an element which has been brightly illuminated, the potential of the signal plate is made negative because of the arrival thereupon of charging electrons which are greater in number than the sum of the secondary electrons emitted owing to bombardment by the electrons of the cathode ray beam and the total photo-electric electrons emitted.

When the cathode ray strikes an element which has not been illuminated since the last scan, no charge is given up by the ray, the number of secondary electrons emitted being equal to the number of electrons arriving; but at this instant the potential of the signal plate will be positive owing to the steady photo-electric discharge occurring from all the elements. Thus the signal generated across the resistance will represent true differences in light and shade between successively scanned elements but will not give any indication of the average illumination.

In order that the average illumination may be transmitted, the D. C. component of the signal may be established at some convenient point, for example in the manner set forth in co-pending application Serial No. 720,205. According to the method described in this prior application, the signal is caused at intervals to assume maximum or minimum values differing from picture "black" by a fixed amount but lying outside the range of picture signals and the D. C. component is inserted at any desired point with reference to these recurring maxima or minima.

These recurrent maxima or minima may be established in the case of a cathode ray system such as that above described by cutting off the cathode ray at the end of each scanning stroke so that there is no bombardment of the "mosaic" screen during the return stroke, that is to say whilst the ray is being returned to one side of the screen after scanning one strip of the image. Thus, during the return stroke, no charge is delivered to the "mosaic." The signal generated at this time on the signal plate will not necessarily be zero, but will depart from zero by an amount depending upon the total steady photo-electric current arising from electrons leaving the "mosaic." The signal, however, corresponds to that generated, during a scanning stroke, when scanning an unilluminated element and therefore corresponds to full black. Consequently by shutting off the cathode ray beam during each return stroke, recurrent signals of value corresponding to full black are obtained. A pulse in the "blacker than black" sense may be superimposed upon each of the black signals and the recurrent minima so obtained may be

used in the manner described in the co-pending application above referred to, to re-establish the average picture intensity.

The pulses in the "blacker than black" sense may also be used to control the generation of the saw-tooth scanning oscillations and, by applying them to a modulator electrode in the cathode ray tube, they also serve to cut off the ray during return strokes.

In the above discussion it has been assumed that the average brightness of the image remained constant. If, however, the average brightness should change suddenly, the operation of the tube, during the first scanning cycle after the change, will be quite different from that described above. A sudden change of image brightness will cause a sudden change in the photo-electric current from the "mosaic" and this change will cause a momentary additional current in the signal plate circuit. The additional current will be opposite in sense to that associated with the change when considering changes from element to element with the average brightness constant. For example if the image be assumed to be quite dark, then the whole "mosaic" will remain fully charged and no signals will be transmitted during scanning, the conditions during the forward (or scanning) stroke being the same as those during the return stroke when the ray is cut off.

If the "mosaic" now be suddenly illuminated, there will flow from the signal plate a photo-electric current tending to make the signal plate positive by virtue of the resistance in series with it. The signal so generated would normally be associated with a black portion of the screen and therefore this new signal, generated by a sudden increase in average brightness, is in the reverse direction to that normally associated with brighter illumination. In effect the signal represents "blacker than black".

Immediately after the change of illumination, the cathode ray beam will not deliver large charges to the "mosaic" because the increased light will not have been active for long enough to discharge the "mosaic" appreciably. There will not therefore be any marked change of signal during return strokes, when the ray is cut off, and the device for re-establishing D. C. will not operate immediately to change the D. C. component of the signal in such a way as to represent the change in brightness that has occurred. At the end of one scanning cycle (when the image has been completely scanned once since the change) normal operating conditions will have re-established themselves: during scanning strokes the signal plate will be driven towards the negative condition by the charge delivered by the cathode ray and during return strokes the signal plate will tend towards positive owing to the steady photo-electric current flowing.

Similar, but rather more dangerous conditions arise when the illumination of the "mosaic" is suddenly reduced. There may first be considered the worst case which occurs if the image which is being transmitted has a uniform intensity equal to the brightest white transmitted (referred to as full white) and if this image be replaced suddenly by complete blackness. Before the change all the photo-electric elements are fully discharged by photo-electric current in the intervals between successive scannings by the ray and the ray delivers the maximum charge as it passes over the elements. At the end of each scanning line and during the return stroke this charging action ceases and a large positive pulse is generated on the signal plate owing to the un-neutralized photo-electric discharge of the elements. The signal generated then consists of small negative values followed by large positive pulses constituting the minima which are used for inserting the D. C. component. When this component is inserted the signals consist of substantially steady strong signals representing full white interspersed with returns of short duration to a level corresponding to full black, corresponding to the return strokes.

When the illumination is suddenly reduced to zero, the photo-electric current component is completely stopped. The elements of the first few strips scanned by the ray after the change are still fully discharged by the previous illumination and in consequence there are delivered to these elements by the ray charges which, as there is no photo-electric emission, make the signal plate highly negative. Also during the return strokes there is no photo-electric current to drive the signal plate positive so that no "black" signal, such as was transmitted before the change, is generated. The result for the first instant after the change of illumination is that instead of the full "white" signals falling to "black" level, they rise to a value corresponding to nearly twice full "white" and the "black" signals between strips will rise to a level corresponding nearly to full "white".

Thus the initial effect of reducing maximum brightness of image to zero is to generate a signal corresponding to almost twice full "white", that is to say the transient signals obtained are the reverse of what they should be.

The effect of these transient signals may be either to overload the apparatus, such as amplifiers, radio frequency transmitter or receivers or, if the apparatus is free from overload, to produce a very bright white flash at the receiver at just the moment at which the received picture is intended to become black after being white. Further, the false transient signal is very likely to cause incorrect operation of any device serving to re-establish D. C. either at the transmitter or receiver. Even if no means are provided in the system for re-establishing D. C., the transients produced will probably cause a serious upset of the apparatus.

It is an object of the present invention to provide means whereby the disturbing effect of transients such as above described may be reduced or eliminated.

According to the present invention, a method of transmitting an image of an object comprises the steps of forming an image of the object upon the photo-electric surface of a screen, scanning the screen to generate in an output circuit picture currents representative of the light and shade of the object, generating currents representative of the general brightness of the object and combining these latter currents with the picture currents in such a way as to reduce the amplitude of reverse picture currents produced by transient changes in general brightness of the object.

Further according to the present invention there is provided a method of television transmission in which an image to be transmitted is projected upon a mosaic photo-electric screen and in which the potentials of the mosaic elements are periodically brought to a fixed value by scanning, characterized in that the amplitude of undesired impulses produced in the picture signal circuit by sudden changes in the average in-

tensity of the light falling upon said screen is reduced by developing and superimposing upon said undesired impulses, corrective impulses of opposite sense to said undesired impulses.

The present invention also provides apparatus adapted for use in carrying out the methods above set forth.

The invention will be described with reference to the accompanying diagrammatic drawing, in which Fig. 1 shows one form of apparatus for carrying the invention into effect, and Fig. 2 shows a modification of the arrangement of Fig. 1. Like parts in the two figures are given the same references.

Referring to Fig. 1, a mosaic screen 1 is mounted within a bulbous portion of a closed glass envelope 2 having a cylindrical neck 3 in which are mounted an electron emitting cathode 4 and suitable electron directing electrodes 5. The anode is constituted by a silvering 6 of the inside of the envelope 2 in the neighbourhood of the junction between the bulbous and cylindrical portions thereof. The screen 1 is arranged at an angle of about 60° to the axis of the cylindrical portion and therefore to the mean direction of the cathode ray beam. The deflection of the ray over the screen is effected by means of two pairs of electromagnet coils, of which only one pair, numbered 18, can be seen in the figure, the coils being arranged to produce deflection of the cathode ray in two directions at right angles and being disposed outside the cylindrical part 3 of the tube; the coils are fed with currents of saw-tooth wave-form from a pair of suitable generators, of which one, numbered 19, is shown. Outside the envelope is arranged an optical system 7 adapted to project an image of an object 8 upon the screen 1. The optical axis of the optical system is arranged to be normal to the screen. An arrangement of this kind is described for example by V. K. Zworykin in an article entitled "Television with cathode-ray tubes" appearing in the Journal of The Institution of Electrical Engineers, vol. 73, and commencing on page 437.

The signal plate of the mosaic screen 1 may be connected to the grid of an amplifying valve 9 and through a suitable resistance 10 and bias battery 11 or other source of E. M. F. to earth and to the cathode of the valve 9. The cathode of the valve 9 is connected to the anode of the cathode ray tube which is maintained at a suitable positive potential relative to the cathode of the cathode ray tube by means of a battery or other source 12.

In order to neutralize the transient effects above described, an auxiliary photo-electric cell 13 is arranged with its anode 14 connected to a tapping point on the resistance 10 and its cathode 20 connected through a suitable bias battery 15 or other source of E. M. F. to earth.

The auxiliary photo-electric cell 13 is arranged in a box 16 which is closed excepting for an aperture 17, which may be the aperture in an adjustable diaphragm, and through which the cell 13 receives light from the whole of the object 8. The interior of the box may be blackened. The sensitivity of this cell 13 and the adjustment of the tapping point on the resistance 10 are arranged to be such that, with sudden changes of illumination of the object 8, the transient voltages developed across the resistance 10 by the signal plate of the mosaic screen 1 and by the auxiliary cell 13 are substantially equal and opposite.

It may be noted that with the arrangement described the pulse generated and impressed upon the grid of the amplifying valve 9 during return strokes of the cathode ray, when the ray is cut off, will correspond to full black and will therefore be suitable for use in the re-insertion of the D. C. component when required. This is because the positive voltage produced upon the grid of the valve 9 by the signal plate owing to the photo-electric emission from all the illuminated elements of the "mosaic" will be equal and opposite to the voltage produced by the auxiliary cell 13 whatever may be the brightness of illumination of the object.

The relative sensitivities of the photo-cell constituted by the "mosaic" screen and signal plate and the auxiliary cell may be adjusted in any other known or suitable manner, for example by adjusting the relative amounts of light falling upon the two devices with the aid of suitable adjustable diaphragm stops. The correct adjustment may be determined by causing the brightness of illumination of the object to vary rapidly and so adjusting the relative sensitivities that the signals obtained correctly represent the changes in illumination.

For very rapid alternation of illumination, such as an illumination which changes at a frequency much greater than the frame frequency, no appreciable output signal should be produced. No transient having a duration less than the time of one complete scanning cycle can be accurately transmitted, although a very intense transient such as a electric spark discharge may be transmitted owing to it causing a rapid discharge of the mosaic elements and being therefore transmitted in the form of a flash of lower intensity and longer duration.

When transmitting pictures from film, the successive frames being projected one at a time upon the "mosaic", it is possible to move the film forwards during the scanning of the "mosaic." If this is done with an uncompensated system, however, the sudden change in illumination of the mosaic owing to the interposition of a shutter or even, if no shutter is used, owing to the black strip between frames, produces an undesired transient in the middle of the picture signals. With the aid of the compensating arrangement of the present invention, however, the film may be moved forward during the scanning cycle without the generation of a harmful transient and more time is therefore available for moving the film than the interval between the transmission of two successive frames and these intervals may be made as short as practicable.

It is not necessary to focus an image of the object 8 upon the auxiliary cell 13, in fact this is usually undesirable because the cathode of the auxiliary cell may not be of uniform sensitivity over its surface. Referring now to Fig. 2, which shows a modification of the arrangement of Fig. 1, an image of an object 8 (which may be a cinematograph film) to be transmitted is projected by the aid of light source 21 on to the mosaic screen 1 of a cathode ray tube 2, 3 which contains within its envelope the electrodes 14 and 20 of an auxiliary photo-electric cell 13.

An image of the object 8 is also thrown on to the cathode 20 of the cell 13 by the aid of a separate light source 22 and the optical system 27. The output of the "mosaic" cell is amplified in amplifiers 9 and 23, while the output from the auxiliary cell 13 is separately amplified in am-

plifier 24. The outputs from amplifiers 23 and 24 are mixed together in opposition at 25, and the combined output is fed to a transmitter 26.

It is desirable in the arrangement shown in Fig. 2 either that the time constants of the coupling or couplings in the amplifier 9, 23 and in the amplifier 24 which determine the lower cut-off frequency, be made greater than 1/25th of a second (where 25 pictures are transmitted per second) or that the time constants of the two amplifiers 9, 23 and 24 should be made substantially equal to one another.

Although the invention has been described in some detail with reference to a particular form of cathode ray tube, it is also applicable to other forms of "mosaic" type tubes which tend, on a change of illumination of the object, to generate a transient having a sense opposite to that normally corresponding to that change of illumination.

Further the invention is not limited to systems in which the D. C. component is retained or re-inserted before transmission of the signal. It can also be applied to systems in which the D. C. component is suppressed or at least not utilized.

I claim:

1. Apparatus for transmitting an image of an object, said apparatus comprising a mosaic screen of mutually insulated photo-electric elements, optical means for directing light from said object along a first optical path to form an image of said object upon said screen, scanning means for periodically bringing said elements to a fixed potential by scanning, an output circuit associated with said screen for receiving picture signals generated during said scanning, an auxiliary light sensitive device, means for projecting light from said object along a second optical path distinct from said first path upon said auxiliary device to generate therein auxiliary signals representative of the general brightness of said object, and means for feeding said auxiliary signals into said output circuit directly in opposition to said picture signals the coupling means between the auxiliary signal generating means, and the video amplifier having a time constant substantially equal each to the other.

2. Apparatus for transmitting an image of an object, said apparatus comprising a mosaic screen of mutually insulated photo-electric elements, means for forming an image of said object upon said screen, scanning means for periodically bringing said elements to a fixed potential by scanning, an output circuit associated with said screen for receiving picture signals generated during said scanning, an auxiliary light sensitive device, means for projecting light from said object upon said auxiliary device to generate auxiliary signals representative of the general brightness of said object, means for adjusting the amount of said light and means for feeding said auxiliary signals directly into said output circuit in opposition to said picture signals the coupling means between the auxiliary signal generating means, and the video amplifier having a time constant substantially equal each to the other.

3. Apparatus for transmitting an image of an object, said apparatus comprising a mosaic screen of mutually insulated photo-electric elements, scanning means for periodically bringing said elements to a fixed potential by scanning, an auxiliary light sensitive device, an envelope containing said screen, said scanning means and said device, means for directing light from said object along a first path to form an image of said object upon said screen, an output circuit associated with said screen for receiving picture signals generated during said scanning, means for directing light from said object, along a second path different from said first path, to fall upon said auxiliary device and thereby to generate auxiliary signals representative of the general brightness of said object, and means for feeding said auxiliary signals directly into said output circuit in opposition to said picture signals the coupling means between the auxiliary signal generating means, and the video amplifier having a time constant substantially equal each to the other.

4. Apparatus for transmitting an image of an object, said apparatus comprising a mosaic screen of mutually insulated photo-electric elements, means for continuously maintaining an image of said object upon said screen, scanning means for periodically bringing said elements to a fixed potential by scanning, an output circuit directly associated with said screen for receiving picture signals generated during said scanning, an auxiliary light sensitive device, means for projecting light directly from said object upon said auxiliary device to generate auxiliary signals representative of the general brightness of said object, and means for feeding said auxiliary signals directly into said output circuit in opposition to said picture signals the coupling means between the auxiliary signal generating means, and the video amplifier having a time constant substantially equal each to the other.

5. Apparatus for transmitting an image of an object, said apparatus comprising a mosaic screen of mutually insulated photo-electric elements, optical means for directing light from said object along a first optical path to form an image of said object upon said screen, scanning means for bringing said elements to a fixed potential by scanning, an output circuit associated with said screen for receiving picture signals generated during said scanning, an auxiliary light sensitive device, means for projecting light from said object along a second optical path distinct from said first path upon said auxiliary device to generate auxiliary signals representative of the general brightness of the object, and means for feeding said auxiliary signals into said output circuit directly in opposition to said picture signals.

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