April 4, 1939. W. F. TEDHAM 2,153,163

TELEVISION TRANSMITTING AND THE LIKE SYSTEM

Filed Nov. 23, 1934

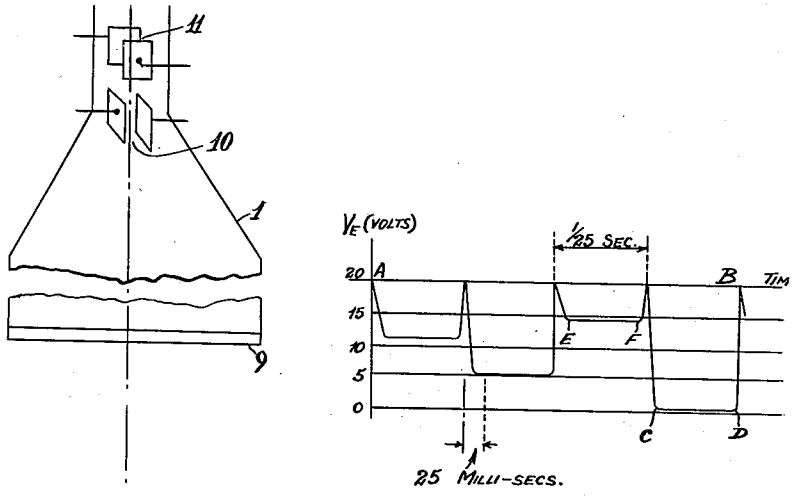


Fig. 2.

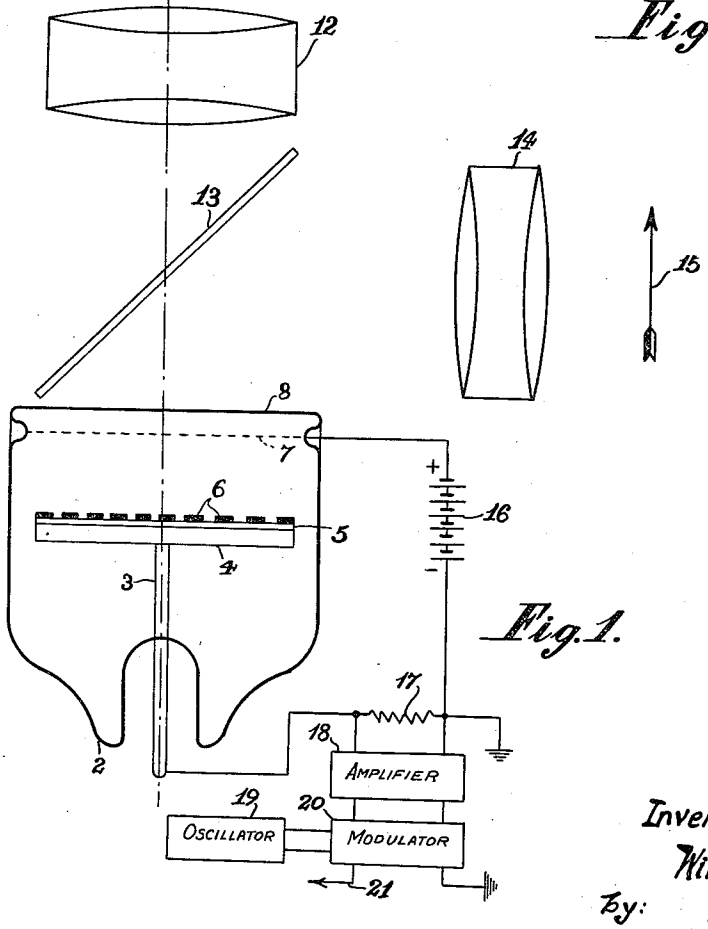


Fig. 1.

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Patented Apr. 4, 1939 2,153,163

UNITED STATES PATENT OFFICE

2,153,163

TELEVISION TRANSMITTING AND THE LIKE SYSTEM

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Application November 23, 1934, Serial No. 754,385
In Great Britain December 6, 1933

6 Claims. (Cl. 178—7.2)

A television transmitter is known in which an optical image of the object to be transmitted is projected upon a mosaic screen of photo-electrically active, insulated elements and the screen scanned by a cathode ray. Each time an element is scanned its potential is lowered to a fixed datum level by the electrons of the cathode ray and in between scans is raised, by photo emission of electrons, to a value determined by the intensity of light falling upon the mosaic screen from the object. Now it has been found that if, in such a tube, an oxide coated cathode is used, as is desirable since these cathodes have a high emission, a small quantity of gas which is probably oxygen is emitted slowly from the cathode; whilst this gas is insufficient to soften the tube appreciably it has the effect of damaging the photo-electric elements of the mosaic screen, when these are of caesium on silver for example, by oxidising the free caesium.

A transmitter is also known in which an optical image of the object to be transmitted is projected intermittently upon a mosaic photo-electric screen and the screen scanned by a light beam during those periods when the screen is unilluminated by light from the object. In between each scan each element acquires a charge proportional to the time for which light from the object falls upon it and since light does not fall continuously upon the object this charge is comparatively small and seriously reduces the efficiency of the system. Also, since the light beam is operated by mechanical means the arrangement suffers from well known disadvantages inherent in mechanically operated scanning systems such, for example, as those arising out of the large inertia of the moving parts.

It is an object of the present invention to provide a television transmitter in which a mosaic screen of photo-electrically active elements is scanned with the aid of a radiant energy, such as light, which is comparatively harmless to the elements.

It is another object of the present invention to provide a method of transmitting images of an object to a distance in which an optical image of the object to be transmitted is projected continuously upon a mosaic screen of photo-electrically active elements whilst the elements are scanned by a beam of radiant energy, the optical image operating during substantially the whole time between successive scans of any one element, to produce a photo-electric emission of electrons from that element.

The invention will now be described with the aid of the accompanying diagrammatic drawing, in which—

Fig. 1 illustrates television transmitting apparatus arranged and adapted to operate in accordance with the present invention, and

Fig. 2 is a graph illustrating the functioning of the apparatus of Fig. 1.

Referring now to Fig. 1, a television transmitter comprises a cathode ray tube 1 and a separate evacuated glass cell 2 containing two electrodes. One of the electrodes of the cell, namely the cathode 3, consists of an aluminium plate 4 bearing on one face a thin uniform layer of aluminium oxide 5 which in turn bears a mosaic screen 6 of photo-electrically active elements separated from one another. Henceforth the aluminium plate 4 will be called the "signal plate" of the tube. The thickness of the oxide layer 5 is such that if an element of screen 6 is maintained at a few volts positive with respect to the signal plate 4 a leakage of electrons occurs from the plate to the element, so that although the elements will be spoken of as being insulated from one another, the insulation is not perfect. There may be ten thousand elements to a square inch and each element may consist, for example, of caesium deposited upon silver oxide. The anode 7 of the cell is in the form of a plane sheet of fine, wide-mesh, wire gauze and is disposed a short distance away from the cathode 3 in a plane parallel to the latter electrode. The anode 7 is maintained at, for example, twenty volts positive with respect to the signal plate 4 of the cathode 3 and both electrodes are disposed in planes parallel to a plane, transparent, end wall 8 of the cell 2.

Facing this end wall 8 is the cathode ray tube 1 which may be of any known or suitable kind. The tube is provided with a fluorescent screen 9, (preferably of a material such as calcium tungstate, which has a short time lag) disposed in a plane parallel to the wall 8, and with means such as two pairs of electrostatic plates 10 and 11, for causing the ray to scan the fluorescent screen 9 in any suitable manner, preferably at constant speed.

Between the tube 1 and the cell 2 is an optical system 12 adapted to project an image of the moving fluorescent spot through the wire mesh anode 7 of the cell 2 on to the mosaic screen 6, the mosaic screen being scanned in this manner with a light beam of substantially constant intensity derived from the cathode ray tube 1.

Also disposed between the cell 1 and the tube 2 is a half-silvered mirror 13, inclined at about 45° to the planes of the cell electrodes 3 and 7. This

mirror is adapted, in conjunction with suitable lenses 14, to project an image of the object 15 (to be transmitted) through the anode 7 of the cell 2 on to the mosaic screen 6. The image of the object 15 is projected continuously onto the mosaic screen 6 and scanning of this screen, which is effected simultaneously, is also carried out as continuously as possible. If interruptions in the scanning process are made, say for example, to enable synchronising signals to be interposed between trains of picture signals, these interruptions should be made as short as possible.

If desired the half-silvered mirror 13 may be replaced by an apertured mirror, the scanning beam of light passing from the tube 1 to the cell 2 through the aperture in the mirror.

The anode 7 of the cell 2 is connected to the positive terminal of an electric current source 16, the other terminal of the source being connected to one end of a high "load" resistance 17 and to earth. The other end of the load resistance 17 is connected to the signal plate 4 and potentials developed across the load resistance 17 are amplified in an amplifier 18, superimposed upon a carrier wave, generated in an oscillator 19, by means of a modulator 20 and transmitted from aerial 21.

The transmitter is operated as follows:

An optical image of the object 15 to be transmitted, whether it be moving or stationary, is projected upon the photo-electric surface of the mosaic screen 6 and the latter is simultaneously scanned with light derived from the cathode ray tube 1, at a rate of twenty-five times per second, for example.

The potential changes of an element during scanning, relative to the anode potential, are illustrated in Fig. 2, in which ordinates (V_E) represent the potential of an element and abscissae represent time. The potential of the anode 7 remains constant at the value shown by line AB.

The intensity of the scanning light beam, which is equivalent to about one lumen per square inch, is sufficient to cause a saturation emission of electrons from the photo-electrically active element scanned to the wire gauze anode 7. Consequently each time an element is scanned it is quickly brought up to the potential of the anode, that is to say, is raised to twenty volts positive with respect to the potential of the signal plate 4. If twenty-five complete scans of the object take place every second, the potential of each element is brought to the level AB (Fig. 2) every 25th of a second. At each scan the leakage of electrons across the oxide layer 5 is negligible compared with the photo-electric saturation emission of electrons.

After the scanning beam passes off an element, the photo-electric emission drops to a value which is below the saturation value and which is dependent upon the intensity of the light reaching the element from the object. During this time, that is to say, in between successive scans, the leakage of electrons across the oxide layer 5 is comparable with, but never less than, the photo-electric emission of electrons. Thus, if no light is reaching an element from the object, immediately after the scanning beam passes off the element, the photo-electric emission drops to zero and the potential of the element falls to that of the signal plate 4 (shown at CD in Fig. 2) owing to the leakage of electrons across the oxide layer. On the other hand if much light falls upon an element from the object, immediately after the scanning beam passes off the element, the photo-electric emission falls to a steady value which is below the saturation value and which is determined by the intensity of the light reaching it. At this stage, however, the leakage of electrons from the signal plate 4 to the element is greater than the photo-electric emission of electrons from the element to the anode 7. The potential of the element relative to the plate 4 therefore falls and this in turn reduces the leakage from the signal plate 4, an equilibrium state is in this manner quickly arrived at when the leakage is equal to the photo-electric emission and at this stage the potential of the element remains steady, at a value (such as that indicated by line EF of Fig. 2) between that of the signal plate 4 and the anode 7, until it is once again brought up to the datum value (that is to say, to the potential of the anode 7) by the scanning beam.

As the scanning beam passes over the whole mossaic screen 6, the potential of each element is in turn raised, relative to that of the signal plate 4, from a value dependent upon the intensity of the light reaching the element from the object to its datum value (represented by line AB in Fig. 2) and then allowed to fall back to a value determined by the nature of the object.

The potential pulses generated in this manner are transmitted through the small condensers formed by the individual mosaic elements and the signal plate 4, the oxide layer 5 constituting the dielectric and develop corresponding potential differences across the resistance 17.

Now a mosaic screen having 10,000 elements to a square inch can be constructed conveniently and the thickness of the oxide layer 5 can be made such that each element has a capacity of 5×10^{-14} farads to the signal plate 4. A good photo-electric surface will emit 14.4×10^{-6} amperes per lumen and the maximum illumination of the mosaic screen 6 which can be derived from a bright object is about 10 foot-candles.

An illumination of 10 foot-candles is produced by 10 lumens falling upon an area of 1 square foot. Therefore an illumination of 10 foot-candles on one square foot of photo-electric surface produces a photo-electric emission of 10 (14.4×10^{-6}) amperes, so that this illumination causes one element of area 10^{-4} sq. inch to emit

$$\frac{14.4\times10^{-5}\times10^{-4}}{144}$$

amperes or 10^{-10} amperes.

Assuming for the moment that the oxide layer 5 acts as a perfect insulator, the charge acquired by an element in between successive scans, that is to say, in $\frac{1}{25}$ second, is $\frac{1}{25}\times10^{-10}$ coulombs, and the potential acquired by the element in this time is therefore

$$\frac{\frac{1}{25}\times10^{-10}}{5\times10^{-14}}$$

volts or 80 volts.

In practice, however, the oxide layer 5 is not a perfect insulator, the maximum illumination to be expected from the object may be less than 10 foot-candles and the photo-electric emission from a mosaic surface may be less than 14.4×10^{-6} amps. 10 volts may therefore be taken as a safe value for the maximum voltage to which an element is raised owing to a bright illumination from the object.

Now as indicated above the leakage from the signal plate 4 to an element must never be less than the photo-electric emission from that element. The maximum photo-electric current is 10^{-10} amps. and at this value the potential difference between the element and the plate 4 is 10

volts so that the above condition is satisfied if the resistance of the oxide layer 5 between one element (of area 10^{-4} sq. inch) and the plate is 10^{11} ohms. That is to say, with the values assumed above, the oxide layer 5 must have a resistance of 10 megohms per square inch. If it is less than this the picture signals will be of reduced intensity. The value of the resistance is adjusted by controlling the oxidation of the aluminium signal plate 4.

With the figures given above it is found that each element is raised to its datum potential practically instantaneously when scanned and falls to its equilibrium or picture potential in about 25 milliseconds.

The layer 5 of aluminium oxide between the aluminium signal plate and the photo-electric elements may be replaced by a thin layer of a vitreous enamel. Alternatively the mosaic screen 6 of mutually insulated photo-electric elements may be replaced by a highly-resistive continuous screen of photo-electric material provided that the screen has a sufficiently high transverse resistance to prevent the charges acquired by small elements of the screen from leaking away to neighbouring elements at an appreciable rate.

In the preferred form of the invention scanning is effected with the aid of a light beam derived from a cathode ray tube, but it lies within the scope of the invention to use for scanning a light beam which is mechanically swept over the mosaic screen. In this case, however, the difficulties inherent in mechanically operated scanning apparatus are introduced.

I claim:

1. A television transmitting apparatus comprising a sealed envelope containing a signal electrode, a screen consisting of a plurality of photo-electrically active elements, an anode, and a partial insulation between said elements themselves and them and said signal electrode; means for maintaining said anode at a positive potential with respect to said signal electrode; optical means for projecting an image of the object to be transmitted upon said elements causing them to emit photo-electrons; means for scanning said elements with a beam of radiant energy such as light causing another emission of photo-electrons, said emissions resulting in leakage currents from any of said elements through said partial insulation to said signal electrode, said leakage currents resulting from scanning being at least as great as any of said other leakage currents; an output circuit associated with said signal electrode; and means for transmitting signals generated in said output circuit.

2. A television transmitting apparatus comprising a sealed envelope containing a signal electrode, a screen consisting of a plurality of photo-electrically active elements, an anode, and a partial insulation between said elements themselves and them and said signal electrode; means for maintaining said anode at a positive potential with respect to said signal electrode; optical means for continuously projecting an image of the object to be transmitted upon said elements causing them to emit photo-electrons; means for scanning said elements with a beam of radiant energy such as light causing another emission of photo-electrons, said emissions resulting in leakage currents from any of said elements through said partial insulation to said signal electrode, said leakage currents resulting from scanning being at least as great as any of said other leakage currents; an output circuit associated with said signal electrode; and means for transmitting signals generated in said output circuit.

3. A television transmitting apparatus comprising a sealed envelope containing a signal electrode, a screen consisting of a plurality of photo-electrically active elements, an anode and a partial insulation between said elements themselves and them and said signal electrode; means for maintaining said anode at a positive potential with respect to said signal electrode; optical means for continuously projecting an image of the object to be transmitted upon said elements causing them to emit photo-electrons; means for scanning said elements with a beam of radiant energy such as light causing another emission of photo-electrons, said partial insulation being so as to permit leakage currents resulting from said emissions to flow from any of said elements to said signal electrode, whereby said leakage currents resulting from scanning are at least as great as any of said other leakage currents resulting from illumination by said object so that the potential of an element not being illuminated by said object falls down substantially to that of the signal electrode within the interval between successive scans thereof; an output circuit associated with said signal electrode; and means for transmitting signals generated in said output circuit.

4. Television transmitting apparatus including a sealed envelope having disposed within it a mosaic screen of mutually insulated photo-electrically active elements, a signal electrode partially insulated from said elements and an anode, means for maintaining said anode at a positive potential with respect to said signal electrode, an optical system for projecting an optical image of the object to be transmitted continuously upon said elements, a cathode ray tube having a fluorescent screen, deflecting means for scanning said fluorescent screen with the cathode ray, means for scanning said elements with light derived from said fluorescent screen, an output circuit associated with said signal electrode and means for transmitting signals generated in said output circuit.

5. In a method of television transmission the steps of projecting an optical image of the object to be transmitted upon a screen comprising mutually insulated photo-electrically active elements, scanning said screen to raise elements thereof successively to a fixed datum level of potential and in the intervals between successive scans of an element, reducing the potential of said element, relative to said datum level, to a value dependent upon the brightness of the light with which said element is illuminated by said image in said intervals, and utilizing the changes of potential of said elements to provide signals which are amplified and transmitted.

6. In a method of television transmission the steps of projecting an optical image of the object to be transmitted upon a photo-electrically active screen, scanning said screen to bring elements thereof successively to a fixed datum level of potential and in the intervals between successive scans of an element, lowering the potential of said element, relative to said datum level, to a value determined by the difference between the photo-electric emission of electrons from said element and a leakage of electrons to said element, and utilizing the changes of potential of said elements to provide signals which are amplified and transmitted.

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