July 4, 1939. F. C. P. HENROTEAU 2,164,520

ELECTRICAL IMAGE TRANSMISSION

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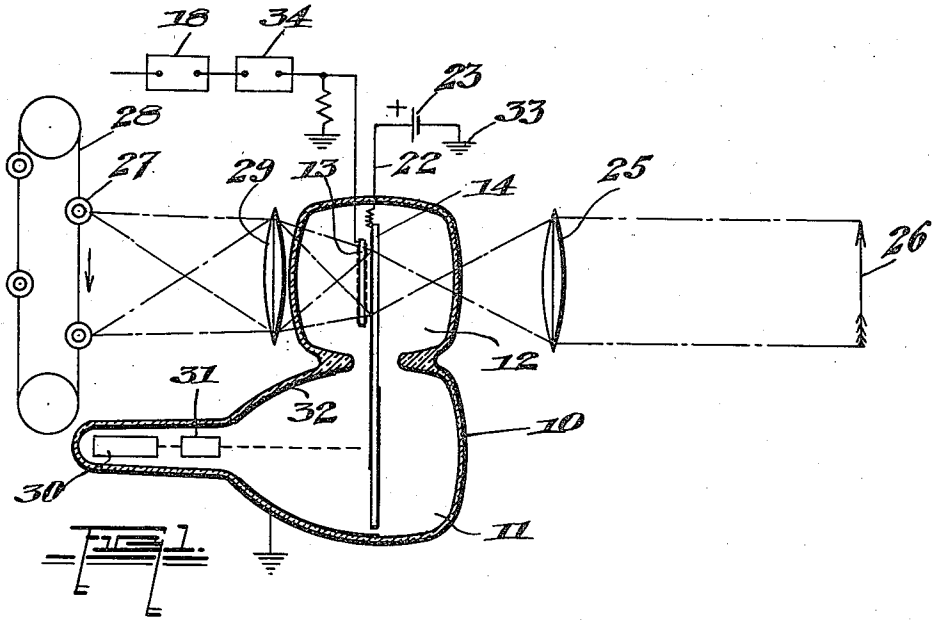


Fig. 1.

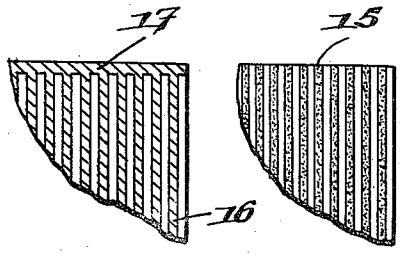


Fig. 2.

Fig. 3.

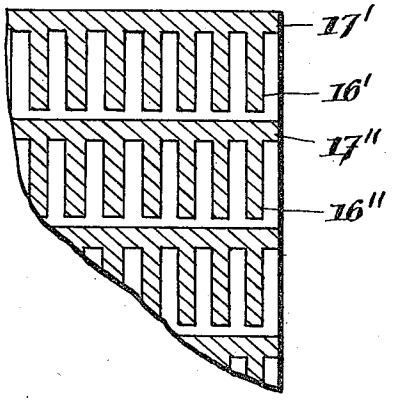


Fig. 5.

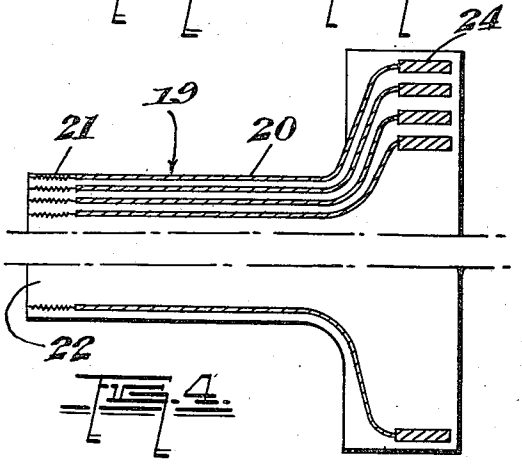


Fig. 4.

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ELECTRICAL IMAGE TRANSMISSION

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10 Claims. (Cl. 178—7.2)

This invention relates to electrical image transmission, which includes the transmission either by wire or wireless of images of actual animate or still objects or of moving or still pictures or transparencies.

In certain systems of television now in use an image is projected on a multiplicity of mutually insulated photosensitive elements arranged on an insulating plate having a metallic backing, so that the potentials of the elements are changed in accordance with the light intensity of corresponding areas of the image. The elements are scanned by a beam of cathode rays with the result that the potential of each element whose potential has been so changed is successively restored, and the flow of electric energy through a transmitting device is varied in accordance with the successive potential changes resulting from the restoration.

This method of scanning the elements by a beam of cathode rays involves the use of electrons having a very high velocity, usually corresponding to a potential difference of 1,000 volts or more, and the bombardment of the elements by such electrons tends to shorten the life of the apparatus.

According to my invention I obtain an effective scanning of the elements with electrons having a much lower velocity, corresponding to a potential difference of certainly not more than 50 volts and almost always less. This restoring of the initial potential of the elements by electrons having relatively low velocities is made possible by the fact that I do not use a directed beam, as in the prior apparatus described above, but successively restore the initial potential of those elements, whose potentials have been changed by the light of the image, by causing each such element or small group of such elements to be struck by an emission of electrons from a different point closely adjacent thereto, it being thus unnecessary to have the high velocities required if the electrons are to be concentrated in a directed beam.

The specific apparatus which I use to carry out my invention comprises a cell containing two adjacent plates of transparent insulating material. On the surface of one plate facing the other are formed a multiplicity of mutually insulated photosensitive elements arranged in strips, and on the surface of this plate facing away from the other plate are a number of strips of metal back to back with the strips on the first mentioned side and connected together and to a transmitter. On the surface of the second plate facing the first plate is a grid composed of parallel photosensitive strips running at right angles to the strips on the first plate and all connected through a resistance to a source of low positive potential. The image is projected through the second plate onto the photosensitive elements, while at the same time a line of light is projected through the first plate onto the second plate across the strips of the grid and is caused to move along these strips, the arrangement being such that, as soon as one line moves off one end of the strips, another line begins its travel along them from the other end.

Each strip has an extension onto a part of the second plate extending beyond the first plate, and a beam of cathode rays is caused to strike each extension in succession a number of times during movement of a line of light along the strips, the number of times that each extension is struck within this period corresponding preferably to the number of strips. Owing to their connection to a source of low positive potential, the strips, though photosensitive, cannot normally emit electrons but whenever the extension of any strip is struck by the beam, the potential of that strip is lowered to a point where electrons may be emitted from that part of it which is illuminated. In this way an effective scanning of the elements of the first plate is obtained with electrons whose velocity is merely that corresponding to the potential difference between the strips of the grid on the second plate and the elements on the first plate.

For a more detailed description of my invention I refer to the attached drawing, in which:—

Figure 1 is a diagrammatic section of the apparatus.

Figure 2 is a partial magnified view of the surface of the first plate facing away from the second plate.

Figure 3 is a partial magnified view of the surface of the first plate facing the second plate.

Figure 4 is a partial magnified view of the grid on the second plate.

Figure 5 is a partial magnified view of an alternative arrangement to that shown in Figure 2.

The apparatus shown in Figure 1 comprises a highly evacuated cell 10 divided substantially into two compartments 11 and 12. Mounted in the cell very close and parallel to each other are two plates 13 and 14 of transparent insulating material such as mica, the first being contained entirely within the compartment 12 and the second extending into both compartments. On the surface of the plate 13 facing the plate 14 are a multiplicity of

mutually insulated photosensitive elements arranged in parallel strips 15, which are separated from each other by bare portions of the surface. On the surface of the plate 13 facing away from plate 14 are metallic strips 16 back to back with the strips 15 and having a common connection 17 to a transmitting device 18. Since the strips 15 and 16 are arranged back to back, the intervening portions of the plate 13 are transparent so that light may shine through them onto the plate 14. On the surface of the latter facing the plate 13 is a grid 19 composed of parallel photosensitive strips 20 connected through high resistances 21 and a connection 22 to the positive pole of a battery 23 of low voltage. The strips 20 are at right angles to the strips 15 and 16 on the plate 13 and are separated by bare portions of the plate 14 so that light may pass through the latter to strike the elements on the plate 13. The strips 20, moreover, run along the plate 14 beyond the plate 13 into the compartment 11 where they terminate in extensions 24, which, as shown in Fig. 4, may be of greater width and spacing than the strips, and need not be of photosensitive material.

Outside the cell 10 is a lens 25 arranged to focus an image 26 on the photosensitive elements on the plate 13, and outside the cell on the opposite side are a plurality of sources of light 27 in the form of lamps with straight filaments arranged on an endless band 28 moved at a suitable speed. A lens 29 is arranged to focus the image of the filament of a lamp on the grid across the strips 20 and the lamps are placed at such a distance apart on the endless band that the images of two filaments are never projected on the grid at the same time. In a suitable pocket in the chamber 11 is arranged a cathode ray gun 30 provided with a single pair of deflecting plates 31, so that the beam of cathode rays may be caused to pass back and forth across the extensions 24. The walls of the chamber 11 have a grounded metallic coating 32 to act as a shield between the chamber 12 and the cathode ray apparatus. To complete the shield there is preferably a metallic coating on the back of the part of plate 14 extending into the chamber 11.

The apparatus described operates as follows:

When the image 26 is projected on the photosensitive elements on the plate 13, the potentials of these elements are changed in accordance with the light intensities of corresponding areas of the image, the electrons emitted being attracted to the nearest strip 20 and passing to ground at 33.

At the same time that the image to be transmitted is projected on the photosensitive elements, the image of the filament of one of the lamps 27 is projected on the grid 19 across the photosensitive strips 20 and is caused to move along the strips by movement of the endless band 28. While this is happening the beam of cathode rays from the gun 30 is caused by the deflecting plates 31 to sweep across the extensions 24 of the strips 20. The potential of the battery 23 is sufficient normally to prevent the emission of electrons from illuminated portions of the strips 20 but each time the beam of cathode rays strikes an extension 24, the potential of the corresponding strip 20 is lowered so that electrons may be emitted from the illuminated portion of it, the lower potential of the strip preferably being such, however, that emission will take place only if the potential of the adjacent photo-sensitive element or elements on the plate 13 has been changed by the light of the image to be transmitted.

There will thus be an emission successively from each point of the strips 20 which is closest to an element on the plate 13 whose potential has been changed by the light of the image to be transmitted. Such emission will strike the element and restore its initial potential with the result that, through the capacitative coupling with the metallic strips 16, there will be a corresponding release of energy to the transmitting device 18, the flow of electric energy through this device being thus controlled in accordance with the successive potential changes resulting from successive restorations.

Where moving images are to be transmitted, the total quantity of incident light integrated over the elements of the strips 15 is not constant, and the average potential of the strips 16 therefore varies; such variation is however of low frequency compared with the frequencies involved in the transmission of the image and may be prevented from affecting the transmitter 18 by means of a filter 34.

In some cases the successive reduction of the potential of the strips 20 on the plate 14 may give rise, by reason of the capacitative coupling between these strips and the strips 16 on the plate 13, to an approximately sinusoidal variation of potential at the grid of the first amplifying valve. This interference may be neutralized by applying another sinusoidal variation of equal magnitude and opposite phase.

In order to produce a regular scanning action, it is desirable that the potentials of the strips 20 should be reduced sufficiently to allow electrons to be emitted only during the passage of the cathode ray in one direction across the extensions 24. This may be obtained by so controlling the deflecting plates 31 that the beam in its return movement (during which no electronic emission from the strips 20 is to be allowed), moves so fast across the extensions 24 that insufficient time is allowed to reduce the potentials of the strips 20 to the point at which an electronic emission might take place.

Since the cathode ray is not itself used for scanning the picture area, it may be concentrated to intercept the plate 14 in the form of a strip instead of a spot in the apparatus described. Furthermore, high attraction potentials may be used, since the extensions 24 of the strips 20 are not provided with photosensitive elements which could be rapidly destroyed by the electronic bombardment.

A method of preparing the surfaces of the plate 13 so that it shall have the strips referred to, may be described by way of example. Lines are printed on each side of the plate with printing ink by means of an engraver's copper plate of the kind used for the preparation of half-tone blocks, it being thus possible to print four hundred or more lines per linear inch. The side of the plate which is to face plate 14 is then coated with a thin layer of silver and the other side with a layer of platinum, by the well known evaporation process in vacuum, or by "sputtering". The coated plate is then subjected for about thirty seconds to a temperature of about 1200° F. This destroys the binding material of the ink so that by careful brushing with a camel's hair brush it can be removed in the form of fine powder taking the superimposed metal with it and leaving lines of silver on one side of the plate and lines of platinum on the other side. The plate is then subjected for a short period to a somewhat higher temperature, and this causes the layer of silver

to fuse and separate into silver globules. If the thickness of the layer of silver has been properly chosen it is possible to obtain in this way a coating composed of millions of mutually insulated silver globules per square inch of the plate. The silver globules are then rendered highly photosensitive by oxidation and treatment with caesium in the known manner.

The side of the plate 14 facing the plate 13 should first be printed, then coated with platinum and then with silver, with the result that platinum lines coated with silver are obtained. These lines may then be made photosensitive by oxidation and treatment with caesium as mentioned above.

While I have disclosed specifically the use of light to cause the emission of electrons from the strips 20, such emission might, if the plate 13 were perforated, be caused by means of other radiation such as a beam of cathode rays which, if used, would scan the plate 14 in the usual manner, but I prefer to use light since an emission of electrons of lower velocity is obtained in this manner and the plates may, when light is used, be sandwiched between two quartz plates, with the result that the durability of the apparatus is increased.

I claim:

1. In a television system wherein is provided a multiplicity of mutually insulated photosensitive elements arranged in a plane together with a plurality of photosensitized areas closely adjacent to the photosensitive elements, the method of electrical image transmission which comprises the steps of projecting an image on the multiplicity of mutually insulated photosensitive elements arranged in a plane so that the potentials of such elements are changed in accordance with the light intensities of corresponding areas of the image, electronically reducing from a predetermined initial value the potential of the photosensitized areas sequentially, optically ejecting electrons from the photosensitized areas, restoring the initial potential of the photosensitive elements by the optically ejected electrons, and varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

2. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials of such elements are simultaneously changed in accordance with the light intensities of corresponding areas of the image, means for reducing from a predetermined initial value the potential of a plurality of photosensitive surfaces adjacent the said elements, means for emitting electrons from the photosensitive surfaces, means for restoring the initial potentials by the emitted electrons of those elements whose potentials have been changed, and means for varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

3. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials of such elements are simultaneously changed in accordance with the light intensities of corresponding areas of the image, means for electronically reducing from a predetermined initial value the potential of a plurality of photosensitive surfaces adjacent the said elements, means for optically releasing electrons from the photosensitive surfaces, means for restoring the initial potential by the released electrons of those elements whose potentials have been changed and means for varying the flow of electric energy through a separate transmitting device for each of said portions in accordance with the successive potential changes resulting from such restoration.

4. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials of such elements are simultaneously changed in accordance with the light intensities of corresponding areas of the image, means for electronically reducing from a predetermined initial value the potential of a plurality of photosensitive surfaces adjacent the said elements, means for optically emitting from the photosensitive surfaces electrons having velocities corresponding to a potential difference between the point of emission and any point along their path of travel of less than 50 volts, means for restoring the initial potentials by the emitted electrons of those elements whose potentials have been changed and means for varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

5. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials of such elements are simultaneously changed in accordance with the light intensities of corresponding areas of the image, means for successively electronically reducing from a predetermined initial value the potential of a plurality of photosensitive surfaces adjacent the said elements, means for optically emitting electrons from the photosensitive surfaces, said emitted electrons having velocities corresponding to a potential difference between the point of emission and any point along their path of travel of less than 50 volts, means for restoring by the emitted electrons the initial potentials of those elements whose potentials have been changed and means for varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

6. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials thereof are simultaneously changed in accordance with the light intensities of corresponding areas of the image, a grid adjacent to said elements and composed of parallel photosensitive strips, means for projecting a line of light on the grid across the strips, means for moving the line along the strips, means for normally maintaining all the strips at a positive potential such that electrons are not emitted from them under the influence of said light, means for successively and repeatedly reducing the poten-

tial of said strips, during movement of the line of light along them, to a point where electrons may be emitted from parts illuminated by the light so that the initial potentials of those elements whose potentials have been changed by the light of the image are successively restored by emissions of electrons from different points respectively closely adjacent to said elements, and means for varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

7. Apparatus for the electrical transmission of images which comprises a cell, a multiplicity of mutually insulated photosensitive elements arranged in a plane within said cell, means for projecting an image on said elements so that the potentials thereof are simultaneously changed in accordance with the light intensities of corresponding areas of the image, a grid adjacent to said elements and composed of parallel photosensitive strips, means for projecting a line of light on the grid across the strips, means for moving the line along the strips, means for normally maintaining all the strips at a positive potential such that electrons are not emitted from them under the influence of said light, means for causing a beam of cathode rays to strike each strip in succession a number of times during movement of the line of light along such strip, thus repeatedly to reduce the potential of such strip to a point where electrons may be emitted from an illuminated part of it so that the initial potentials of those elements whose potentials have been changed by the light of the image are successively restored by emissions of electrons from different points respectively closely adjacent to said elements, and means for varying the flow of electrical energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

8. Apparatus for the electrical transmission of images comprising a cell, a first and a second plate of transparent insulating material adjacent to one another within said cell, a multiplicity of mutually insulated photosensitive elements on the surface of the first plate facing the second plate, a grid composed of parallel strips of photosensitive material on the surface of the second plate facing the first plate, means for projecting an image through the second plate onto said photosensitive elements so that the potentials of such elements are simultaneously changed in accordance with the light intensities of corresponding areas of the image, means for projecting a line of light through the first plate onto the second plate across the strips of the grid, means for moving the line of light along the strips, means for normally maintaining all the strips at a positive potential such that electrons are not emitted from them under the influence of the said light, means for causing a beam of cathode rays to strike each strip in succession a number of times during movement of the line of light along such strip, thus repeatedly to reduce the potential of such strip to a point where electrons may be emitted from an illuminated portion of it, so that the initial potentials of those elements on the first plate whose potentials have been changed by the light of the image are successively restored by emissions of electrons from different points on the second plate respectively closely adjacent to said elements, and means for varying the flow of electric energy through a transmitting device in accordance with the successive potential changes resulting from such restoration.

9. In a television system wherein an optical image is arranged to fall upon a photosensitized area, the method of scanning the photosensitized area which comprises separately optically scanning the photosensitized area in one direction, and electronically scanning the area in a mutually perpendicular direction to resolve the complete scanning into a series of point scannings.

10. In a television system wherein an optical image is arranged to fall upon a photosensitized area, the method of scanning the photosensitized area which comprises separately optically scanning line by line the photosensitized area in one direction, electronically scanning line by line the area in a mutually perpendicular direction to resolve the complete scanning into a series of point scannings, and producing image signals from the scannings.

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