Jan. 11, 1938. F. C. P. HENROTEAU 2,104,862

TELEVISION METHOD AND APPARATUS

Filed Jan. 4, 1934

FIG. 1

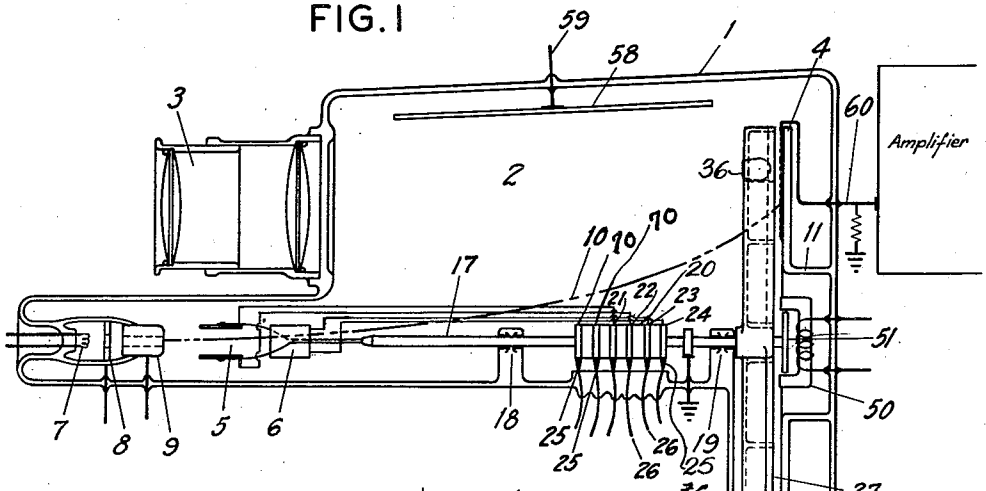
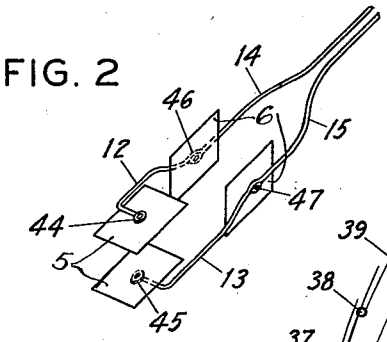


FIG. 2



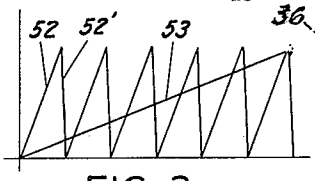


FIG. 3

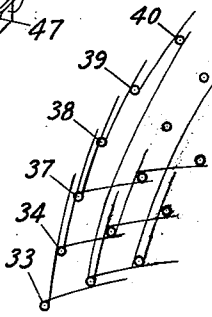


FIG. 5

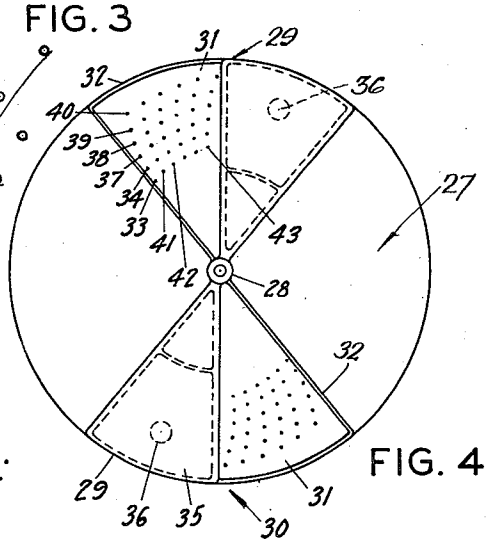


FIG. 4

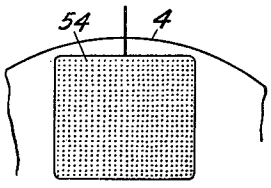


FIG. 7

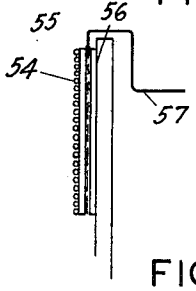


FIG. 8

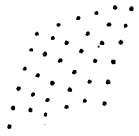


FIG. 6

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TELEVISION METHOD AND APPARATUS

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7 Claims. (Cl. 178—7.2)

The present invention relates to television, that is to say, 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. It may also be used for the detection of objects from which faint radiation is emitted.

The present method is an improvement and variation in the system employed in my prior Patents Nos. 1,903,112 and 1,903,113.

As in the prior patents, the present method is one in which an image is impressed for a comparatively long period of time upon a photoelectric plate comprising a plurality of photoelectric cells in the form of minute globules which are mounted in spaced relation one to the other upon an insulated plate. The image impressed causes the accumulation of a positive charge upon the cells corresponding in magnitude to the intensity of the light of the image and the duration of its impression. The photoelectric globules forming the plate are electrically connected in a circuit as in the prior patents by making the photoelectric plate one element of an electrical condenser. The charges which are stored up by virtue of the impression of the image upon the plate are released by an electron scanning beam with the result that a current corresponding to the intensity of the light accumulated upon each spot over which the beam passes flows in the input circuit of a vacuum tube connected with the plate.

As a result of the passage of the electron scanning beam over a spot upon which the image has been impressed, the potential of the spot should return to its normal base of value. While this is usually the case, it may sometimes happen that all the photoelectric cells do not return to the same potential value and that at times accumulated charges for one reason or another may still reside in minute photoelectric cells when the image is impressed. In the present system, therefore a means is provided whereby minute photoelectric cells are each and all brought back to their normal preoperative condition before the image is again impressed on them.

The scanning according to the method of the present invention is accomplished through the means of an electron beam which is in part controlled by a scanning plate which will be described in detail below. By use of the scanning plate it is possible to obtain a comparatively fine scanning as the plate limits the size of the scanning spot and makes it possible to get an image having a greater number of picture elements per unit area and consequently a finer texture than would otherwise be obtainable. The use of the scanning plate also makes it possible to provide a secret or semi-secret method of scanning, since not only must the exact plate be reproduced and used at the receiving end, but synchronism must be established between the rotation of the plate at the sending end and that at the receiving end.

In the present system a photoelectric plate having a very great number of mutually insulated photoelectric cells may be employed, there being as many as sixteen million cells to the square inch or four thousand cells to the linear inch. The method of obtaining plates of this nature in which all of the cells are uniform and uniformly positioned with respect to one another, forms a part of the discovery of the present invention, and is in part instrumental in the production of a fine grained image. This also will be understood from the description given below:

Without going into further details regarding the objects and advantages of the present invention, an embodiment of the same will be described in connection with the drawing attached to the specification, in which:

Figure 1 shows somewhat schematically the arrangement and elements of the transmitting tube,

Figure 2 shows a detail of control plates for the electron beam,

Figure 3 shows the characteristic of the voltages impressed upon the control plates.

Figure 4 shows a detail of the scanning plate,

Figure 5 shows a detail of the arrangement of the scanning holes,

Figure 6 shows a modification of the arrangement shown in Fig. 5,

Figure 7 shows a plan view of the photoelectric plate, and

Figure 8 shows an end view of this plate.

The arrangement shown in Figure 1 comprises an evacuated vessel or tube 2 having walls 1 of glass or partly of glass and partly of metal and provided at its front end with a lens 3 adjustable to focus an image upon the photoelectric screen 4 mounted in a fixed position in the tube by means of a bracket 11. Mounted also at the front end of the tube are means of the usual type, comprising an electron emitting filament 7, a control grid 8 and a hollow anode 9, for producing a focussed beam 10 of cathode rays, whose movement is controlled by the control plates 5 and 6. The plates 6 are fastened by means of insulating connections 46 and 47 to the ends of the arms 14 and 15 respectively and the plates 5 by means

of the insulating connections 44 and 45 to the ends of the arms 12 and 13 formed as extensions of the arms 14 and 15 respectively, which latter and thus the control plate assembly as a whole, are carried by a shaft 17 rotatable in bearings 18 and 19. The shaft 17 also carries an insulating drum 20 provided about its periphery with conductive rings 21, 22, 23 and 24, each of which is connected to a different control plate as shown diagrammatically in Figure 2 and is connected also to a lead 26 through a brush 25, so that the desired voltage variations may be supplied to the control plates.

Mounted upon the shaft 17 just beyond the bearing 19 and illustrated in detail in Figure 4 is a member 27 composed of a center supporting hub 28 to which are attached two sector elements 29 and 30 diametrically opposed to each other. One part of each sector element comprises a thin flat plate 31 of a thickness approximately of .001 inch, which may be held in place by a frame 32 acting also as a support, and is supplied with openings 33, 34, etc., through which part of the cathode beam 10 may pass. These openings, which can for instance be made by a photo-engraving process, are of the order of .001 inch in diameter more or less, and are spaced apart in such a manner that the scanning beam will be caused to scan the entire image on the photoelectric screen during movement of the scanning plate across the latter. The other part of each sector is a box 35 forming a Faraday cage. The box is composed of metal sides and is closed at the face farthest from the photoelectric plate so that no light from the object lens 3 nor part of the cathode beam can strike the photoelectric screen while the box is passing over it. In each box is provided a light 36, which is supplied with current through the conductive rings 70 and the brushes 25 and is preferably a glow discharge tube, though it may be of another type if desired.

Each scanning plate 31, as indicated in Figure 4, comprises thirty-six scanning holes. It will be noted (the arrangement being shown in more detail in Fig. 5) that the holes 34, 37, 38, 39 and 40 are successively spaced from the hole 33 to the right so that the hole 34 for instance is not aligned with the hole 33. In a like manner the hole 41 is spaced just above the hole 38 and the hole 42 similarly spaced just above the hole 41, the result of such a spacing being that the lowest line across the photoelectric screen 4 will be scanned by the hole 33, the second line by the hole 41, the third line by the hole 42, while the hole 43 will scan a line just preceding that which is scanned by the hole 34. Although in Figure 5 all the holes are shown as being approximately the same size, the holes further from the center may be larger or smaller depending on the effect which it is desired to produce. The scanning screen 31 is moved over the photoelectric plate 4 by the rotation of the shaft 17 which also carries and rotates the pairs of control plates 5 and 6, and the speed of rotation is so adjusted that after one scanning of the thirty-six holes has been completed, the next scanning strikes points of the screen 4 immediately adjacent to the points struck during the first scanning.

Although the plate 31 is indicated as scanning the photoelectric plate in thirty-six lines, this number may be increased or diminished as desired by substituting different plates having more or less holes. It is also possible to vary the arrangement shown in Figure 4 with an arrangement such as is shown in Figure 6, in which successive rows of holes are arranged to scan different rather than consecutive lines. Whatever arrangement is employed at the sending end, the same arrangement must be employed at the receiving end, otherwise the scanning will not correspond. It will thus be noted that a certain secrecy may be provided by the choice of plates and that it will in this way be possible to establish secret methods of television transmission so that subscription to programmes or other commercial advantages may be gained. This system may also be used for secret communications as for instance in transmitting reproductions of telegraphic messages or other code or written signals. The rotation of the shaft is accomplished by means of the synchronous motor 50, which may be of any convenient type, and the rotor 51 of which may be directly mounted upon the shaft 17. By use of the synchronous motor the speed of the rotation of the system may be definitely controlled.

Fig. 3 shows the characteristics of the voltages applied to the control plates. These voltages may be produced by a condenser circuit with definitely computed resistances and reactance as is well known in the art. In the figure the characteristics 52 are applied to the pair of plates 5 to produce the vertical motion of the beam. The characteristic of the voltage applied to the plates 6 is shown at 53 and is of the same type as that shown at 52 only six times as slow in action. The action of the characteristic 52 is to move the cathode beam slowly upward in a vertical direction and drop it sharply as indicated by the section 52′ of the voltage curve, while the action of the characteristic 53 as applied to the plate 6 is to swing the beam over to the right. As a result of these two actions the beam will travel up the first row of holes 33—40, come back to the bottom of the second row, rapidly travel up the second row, come back to the bottom of the third row, and so on until the point 43 is reached. From there it will return to the starting point to repeat its travel. Since each control plate may be individually controlled, the potential applied to the plates may be reversed for causing the beam to travel over both sector elements 29 and 30. In this way two complete scannings of the image may be obtained for every revolution of the shaft.

The photoelectric screen 4 is shown in detail in Figures 7 and 8, in which the dots indicate the individual separated photoelectric cells, these dots 54 being shown exaggerated in Figure 8. The individual cells 54 are preferably mounted on a very thin mica plate 55, preferably about .001 inch thick, the back surface of which is coated by cathode spluttering or plating or in any suitable manner with a metallic coating 56 to provide the other electrode of the condenser. This coating 56, which may be so thin as to be transparent is connected by a lead 57 to the amplifier or modulator for operating the transmitting circuit. Cells on the front of the plate are deposited in a new way which has never before been employed. In this method the plate 55 is placed in an evacuated vessel and sputtered with a cathode stream whereby a uniform volume of the metal which is silver in the present case, is deposited. The thickness of the coating can be carefully regulated by controlling the magnitude of the stream and the duration of the sputtering. When the sputtering has been completed, the plate is treated by a glow discharge, oxygen at two or three millimetres pressure produce or

oxidize the volume on the plate. I have found that unless the gas within the tube is ionized as by an auxiliary discharge in the tube itself or by a method just previously mentioned, no oxidation will take place. The oxidation causes the film to turn a greenish color. When the volume has become oxidized more oxygen or air is admitted to the vessel in which the plate is contained, and the plate is further heated under which process the smaller globules of pure silver gather and form in a uniform structure upon the face of the plate. In experiments which I have tried I have easily obtained sixteen million globules to the square inch or four thousand to the linear inch, and with different methods of control, and by employing different thicknesses of volume coating and variation in temperatures, I am able to increase this number considerably more.

After the globules have been formed they are caesium sensitized whereby they become individual minute photoelectric cells.

In place of the method just described for making the photoelectric plate, the following method may also be employed where the individual cells need not be as small as previously mentioned. In this process an engraved plate may be made in which holes are engraved of the size desired for the individual cells. After the plate has been engraved to make the holes in the plate it is covered with the ordinary carbon ink and printed on a mica or other insulating plate surface. When printed the engraved spots will be light and the rest of the mica plate inked. When the mica plate has become dry it is put in a sputtering tube or sputtered in the usual manner to produce a uniform coating of silver over the entire plate. After this has been done the plate is baked at a high degree temperature sufficient so that the carbon ink will be cracked. The plate may then be removed and brushed. In the spots where the silver is against the plate the silver will remain, but where the silver was over the carbon ink, the silver mixes with the pulverized ink and it may be entirely brushed off. All that remains therefore are the individual spots of silver on the mica plate which may be sensitized in the usual fashion.

In the operation of the device the image is allowed to shine continuously through the lens 3 and be focussed on the screen 4 before which the scanning plates 31 of the sectors 29 and 30 pass successively. The cathode beam and the moving sectors hold relatively the same position, since they are both rotated on the same shaft except of course that the cathode beam passes over the rows of holes in the plates 31 in the manner previously described. When the cathode beam has gone over the holes in the scanning plate once, it has scanned a corresponding series of spots on the screen 4. By the time that the beam begins a second scanning of the plate 31, the latter has advanced by an amount corresponding to the size of one opening, so that upon the second scanning a series of spots are scanned on the screen 4 adjacent to those previously scanned. As the plate 31 passes before the screen 4 the complete scanning is accomplished, each little opening in the plate having scanned one line of the picture. Following the scanning of the screen 4 by which means the charges accumulated on it by the image are restored, the screen is swept over by the box 35 containing the light 36 whereby the charge of each cell in the screen is brought to a definite value, so that each cell may again accumulate its charge from a definite potential level. When the cage 35 of the sector 29 has passed beyond the screen, the image is again concentrated upon the latter and remains so until the plate 31 of the sector 30 appears, at which time the beam which has previously scanned with the plate 31 of the sector 29 begins to scan the plate 31 of the sector 30. This may be accomplished by reversing the potentials upon the pair of plates 5 and 6 so that the beam which would otherwise be thrown downward as the plates are rotated is again turned upwards to scan the second plate 31 coming before the photoelectric screen 4.

The action of the cathode beam 10 is such as to release the electron charges accumulated on the plate at which the point of the beam falls. These charges travel to the anode 58 and cause a current to flow in the external circuit between the conductors 59 attached to the anode and the conductor 60 attached to the rear electrode of the photoelectric plate. These two electrodes may control the grid of an amplifier circuit or a modulator and modulate directly or indirectly a carrier wave.

The present system may be particularly used with high frequencies in view of its ability to give a scanning of a great number of lines. In the present system the electron beam 10 may be larger in diameter than the holes in the plates 31 and the holes in these plates may also be larger than the individual photoelectric cells on the screen 4. If such is the case a single hole will control a number of photoelectric cells. If desirable the size of the holes in the plate 31 may be decreased so that the size of the area scanned will be of the same order as that of the photoelectric cell. At the receiving end of the system all that is necessary is a scanning beam as provided by a cathode ray tube with the means for controlling its intensity and a plate corresponding to the plates 31 of the sectors 29 and 30 rotated in synchronism therewith. The reproduction at the receiving end, it will be obvious, is practically an inverse of the transmission except that in place of the photoelectric plate for modulating or varying the electric current corresponding to the light variation, the intensity of the light is varied corresponding to that of the received electro-magnetic energy. The synchronism of the sending and the receiving plates may be obtained in any well known manner and may be provided if desired by the voltage control on the cathode beams.

Having now described my invention, I claim:

1. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, means for impressing an image on said screen, a scanning plate between the screen and the image, and means for causing the scanning plate to pass before the photoelectric screen between impressions of the image on said screen.

2. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, means for impressing an image on said screen, a scanning system comprising means for creating a cathode beam, a scanning plate between the screen and the image, means for causing the plate to pass before the photoelectric screen, and means moving with the plate for causing the cathode beam to move over its surface.

3. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, said screen being formed as

a condenser with a rear electrode, means for impressing an image on said screen, and means for scanning said screen in small picture areas thereby successively releasing the charge accumulated, said means including in combination a cathode beam and a plate defining the picture areas successively scanned on the photoelectric screen.

4. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, said screen being formed as a condenser with a rear electrode, means for impressing an image on said screen, and means for scanning said screen in small picture areas thereby successively releasing the charge accumulated, said means including in combination a plate, means for moving the plate before the screen, a plurality of holes in the plate each adapted to move along a different line over the screen, and means for causing a cathode beam to move over the holes in the plate.

5. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, means for impressing an image on said screen, a scanning system comprising means for creating and means for controlling a cathode beam, a scanning plate having a plurality of holes adapted to scan successive lines of the photoelectric screen, said control means being adapted to cause the beam to repeat a pattern over the holes, and means for moving the plate before the screen.

6. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, means for impressing an image on said screen, a scanning system comprising means for creating and means for controlling a cathode beam, a scanning plate having a plurality of holes adapted to scan successive lines of the photoelectric screen, said control means being adapted to cause the beam to repeat a pattern over the holes, and means for rotating said scanning plate and said beam to maintain the elements in the same relative relation to one another.

7. In a television system, an evacuated vessel containing a photoelectric screen of individual photoelectric cells, means for impressing an image on said screen, a scanning system comprising a cathode beam and a scanning plate, means for moving said plate before said screen, means for causing said beam to move over said plate a plurality of individual scanning holes in said plate whereby the isolated picture areas on the photoelectric plate are successively scanned and means for equalizing the potential on the individual cells after the scanning has taken place.

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