Aug. 8, 1939. P. T. FARNSWORTH 2,168,768

TELEVISION METHOD

Original Filed Jan. 9, 1928

Fig. 1.

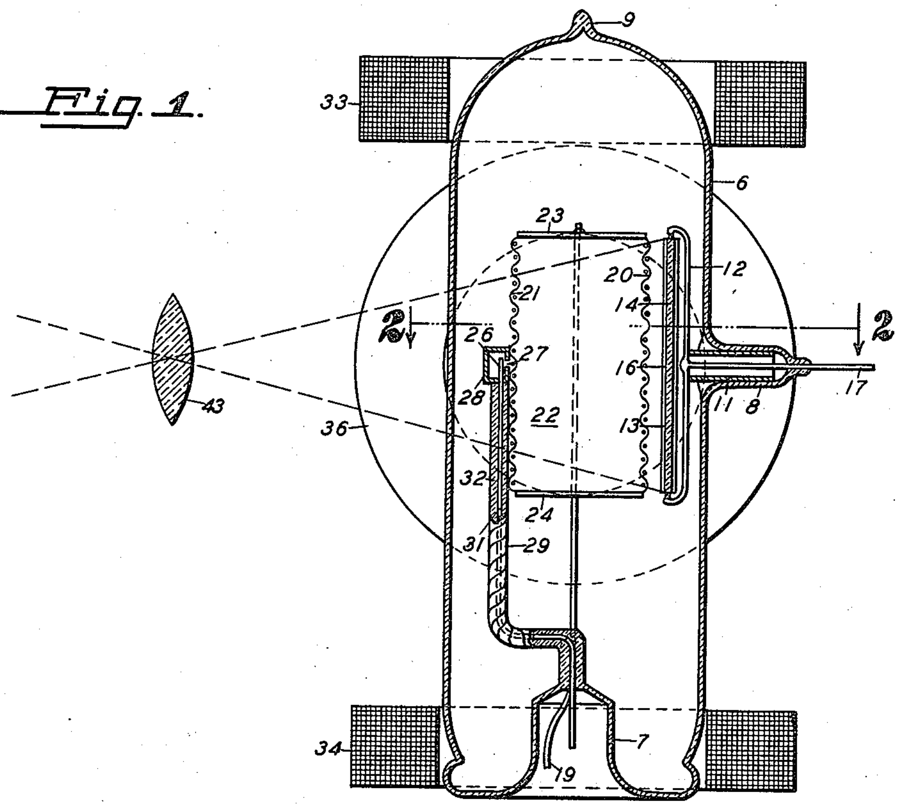


Fig. 2.

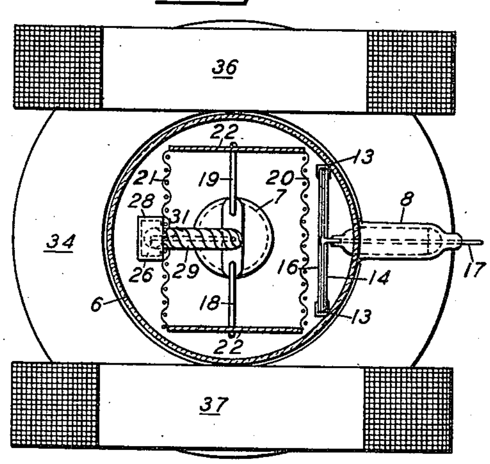
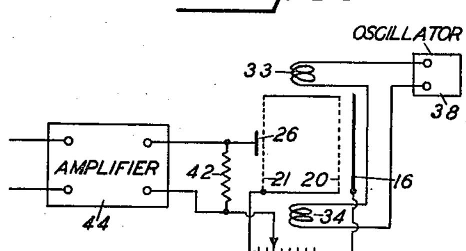


Fig. 3.



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2,168,768

TELEVISION METHOD

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Original application January 9, 1928, Serial No. 245,334, now Patent No. 1,970,036, dated August 14, 1934. Divided and this application April 15, 1932, Serial No. 605,495

10 Claims. (Cl. 178—7.2)

My invention relates to television, this application being a division of my application, Serial No. 245,334, filed January 9, 1928, now Patent No. 1,970,036, granted Aug. 14, 1934, for Photo-electric apparatus.

Among the objects of my invention are: To provide a method of dissecting an image for electrical transmission; to provide a method of thus dissecting an image giving improved definition; to provide a method of increasing the sensitivity of an electrical picture transmitter; and to provide an electrical picture transmission method.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of my invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawing:

Figure 1 is a sectional view of an apparatus utilizing the method of my invention, the plane of section being perpendicular to the cathode and parallel to the axis of the dissector tube. The optical system is shown schematically.

Figure 2 is a sectional view of the same apparatus taken on the line 2—2 of Figure 1. The optical system is not shown in this figure.

Figure 3 is a diagram of the electrical circuit. For clearness in the drawing one pair of deflecting coils and their exciting oscillator are omitted.

In general terms, the method of my invention comprises projecting an image of the field to be pictured upon a photoelectric surface, to cause liberation of electrons in proportion to the illumination of the surface elements. The electrons thus liberated are accelerated with extreme rapidity over a short space and then allowed to pass at constant velocity through an equipotential space, where they are deflected in accordance with a predetermined time schedule. Through this deflection the electrons are separated into distinct trains of energy, one of which is utilized to excite secondary emission of electrons, the secondary electrons thus liberated ultimately forming the picture current, which may be amplified and transmitted.

The method of this invention can best be understood in connection with the description of a preferred form of apparatus utilizing it. Such apparatus comprises an evacuated glass bulb or tube 6 having a stem 7 of the usual type, a side seal 8, and the customary evacuating tip 9.

The side seal 8 comprises a short tube sealed into the side of the bulb. Within this tube is fitted a roll 11 of spring tempered metal, usually nickel, carrying a wire frame 12 which supports the clips 13. These clips grasp the rectangle of plate glass 14, and make contact with a silver film on which is deposited the light sensitive coating 16 which acts as the cathode of the tube. The entire structure is connected to its external circuit by the wire 17 which is connected to the frame 12 and passes through the side seal.

The deposit of light sensitive material upon the cathode is accomplished during the process of evacuation in the customary manner. Metallic potassium is distilled from a reservoir in the exhaust line, and is allowed to condense on the cathode surface. The anode, and the walls of the bulb, except adjacent the cathode, are heated, so that little condensation takes place on these parts. Hydrogen is then admitted to the tube, and in this atmosphere a glow discharge is passed between cathode and anode, converting the potassium to the much more photo-sensitive hydride.

The anode is supported by the stem 7. The wire lead 19 passing through the seal, and the "dummy" 18, which is held by the seal but does not pass through it, are bent to embrace the anode and are welded thereto. The anode is preferably in the form of a box or rectangular prism. The opposite sides or walls 20 and 21 are of fine mesh screen, the side 20 being parallel to the cathode and as close thereto as is structurally practical. The two adjacent walls 22 are sheet metal. They are preferably of low magnetic permeability and electrical conductivity to limit eddy currents as far as possible. Wire frames 23 and 24 around the top and bottom of the anode give it rigidity.

Behind the center of the screen 21 is the auxiliary electrode or target 26 of nickel or other material which is a good secondary emitter of electrons. This is completely shielded with the exception of the single area behind the small aperture 27 in the housing 28 which surrounds the target. The housing 28 is electrically connected to the metallic sheath 29, surrounding the lead 31 from its connection with the electrode 26 to its seal in the stem 7, and insulated from the lead preferably by a tube 32 of boro-silicate glass. The shielding system, comprising sheath and housing, is connected to the anode.

Means are provided for deflecting the electrons emitted from the cathode. Coils 33 and 34, coaxial with the bulb, set up a magnetic field which bends the electron beam transversely of the tube. A second set of coils 36 and 37, is parallel with the anode walls 22. Currents flowing in these coils cause a magnetic field which bends the beam in a direction parallel to the axis of the tube. By passing currents of different frequency through the two sets of coils the beam may be oscillated so that each element of its cross section in turn traverses the aperture 27, as is described in my copending application, Serial No. 159,540, Patent No. 1,773,980, of which application, Serial No. 245,334 above mentioned, is a continuation in part. The oscillators 38, for accomplishing this may be of any suitable character, although I prefer to use the type there described.

A source of potential, conveniently the battery 41, imposes a high positive voltage on the anode with respect to the cathode. The auxiliary electrode is maintained slightly negative to the anode, being connected to an intermediate point on the battery through the high resistance 42.

An optical system, indicated by the lens 43, focuses an image of the picture or view to be reproduced through the anode screens 21 and 20 upon the light sensitive cathode. As the screens are not in the focal plane they cast no discrete shadows, although they do intercept a certain proportion of the rays.

The cathode emits electrons from each elementary area of its surface at a rate proportional to the illumination of the area. These electrons leave the cathode surface with small velocities in random directions. They immediately fall under the influence of the strong electrostatic field from the anode, which accelerates them in a direction normal to the cathode surface until they pass through the screen 20 as an electrical image, or beam of electrons whose intensity normal to the path of the beam is at all points substantially proportional to the corresponding point of the optical image. Beyond this screen they continue to travel with the high velocity thus acquired. While traveling at this velocity they are deflected by the fields from the two sets of coils 33, 34 and 36, 37, and are separated into two trains. The first and by far the smaller of these trains comprises those entering the aperture 27 to strike the auxiliary electrode. The larger train eventually strikes either the wall of the bulb or the anode. This train serves no further useful purpose.

The first train liberates a secondary electron discharge from the target. The electrons thus liberated are attracted to the more positive anode or to the housing 28, carrying a current which flows through a portion of the battery 41 and the high resistance 42 back to the target. This of course refers to the actual electron flow and not to the conventional "current flow". There is thereby set up across the terminals of the resistor 42 a potential which corresponds to an analysis, in accordance with a predetermined time schedule, of the illumination of the cathode. An amplifier 44 connected across the resistor 42 is activated by this potential and its output supplies the picture current for television transmission.

The construction thus set forth has a number of highly advantageous features. The target is shielded from all electron bombardment except that originating from the cathode. This makes the accidental deposition of light-sensitive material on other parts of the tube relatively unimportant. As such deposition is almost certain to occur to some extent this is a valuable property. The light-permeable anode screens permit the image to be formed directly upon the active surface of the cathode, thus escaping many difficulties which are usually encountered. The use of secondary emission gives a current which is from five to twenty times as great as can be obtained by photo-emission alone.

In addition to these advantages, my method gives greatly improved definition. There are two causes for the electrons which leave a small area spreading to impinge upon a larger area of the target, causing blurring or diffusion. The first is their mutual repulsion. Where a narrow pencil is used as in the more usual type of apparatus, this has its maximum effect. In my apparatus the space charge in the beam outside of the portion which is momentarily active counteracts the charge within that portion, and largely negatives this effect. The second cause of diffusion is the random initial velocity with which the electrons leave the cathode. This velocity in general has a component normal to the desired electron path. To render the diffusion due to the normal components negligible the velocity along the path must be made very high in comparison, and this is done by using a high anode potential. The velocity at which the electron travels is proportional to the potential through which it has fallen, and its mean velocity up to the time it reaches the anode is one-half its final velocity. In my device the final velocity is acquired by the time the electron reaches the anode screen 20, and its travel through the substantially equipotential space between the screens is at this final velocity. Its mean velocity from cathode to target is therefore almost twice as great as it would be if the screen 20 were omitted, and diffusion is therefore reduced to about half what it would otherwise be. The result is the same as though the anode voltage were almost doubled, and this without the manifest dangers that doubling the voltage would involve.

In using the term "electrically permeable" in this specification, I mean permeable to cathode ray or electronic discharge, and do not refer to ordinary metallic conduction.

The term "electrical image", as used in this specification and in the claims, is defined as an electron or space current having a cross section which varies in electron density from point to point throughout the section in substantially the same manner as does the optical image to be reproduced in light intensity.

I claim:

1. In television, the steps of forming an electrical image of the field to be pictured, accelerating the electrons constituting said image, deflecting said electrons after they have attained their accelerated velocity, and selecting electrons from successive portions of said image determined by the deflection thereof.

2. In television, the steps of forming an electrical image of the field to be pictured, liberating secondary electrons by bombardment with selected successive areas of said image, and collecting said secondary electrons to produce a signal current.

3. In television, the steps of forming an electrical image of the field to be pictured, deflecting said image, activating a secondary emitter with a predetermined section thereof, and collecting the secondary emission in a transmitting circuit.

4. In television, the steps of forming an electrical image of the field to be pictured, diverting electrons from the component areas of said image into separate trains in accordance with a predetermined time schedule, and causing one of said trains to generate an electron flow by secondary

emission, and collecting said electron flow to form a transmitting current.

5. In television, the steps of forming an electrical image of the field to be pictured, diverting a portion of the electron stream constituting said image, and generating by bombardment with said diverted portion an increased electron flow proportional to said diverted portion of said stream, and collecting said increased flow.

6. In the electrical transmission of pictures, the method of generating a picture current of larger value than that obtainable directly from emission from a photo-electric surface, which comprises the steps of forming an electron image of the field to be pictured, diverting successive portions of said image, bombarding a substance with said electrons capable of electron emission under such bombardment, and collecting the additional electrons thus liberated to produce an increased flow of picture frequency current.

7. The method of producing currents for the electrical transmission of pictures with a photoelectric device comprising a main chamber containing a photo-sensitive cathode and an auxiliary chamber containing an anode, which comprises forming an electron image of the field to be pictured within said main chamber, diverting a portion of said electron image into said auxiliary chamber, and causing a current flow within said auxiliary chamber in excess of the current corresponding to the entering electrons as a result of bombardment by said electrons within said auxiliary chamber.

8. In a television system wherein the television signals are generated by an electronic discharge within an evacuated envelope including an auxiliary chamber, the method of generating such signals which comprises the steps of initiating an electronic discharge which varies in intensity throughout its section as a function of the variation of intensity of illumination throughout the pictured field, directing a minute portion of said discharge into said auxiliary chamber, varying the portion directed into said chamber by deflecting said discharge, and causing the portion received within said chamber to initiate within said chamber by secondary emission of electrons a discharge comprising an increased number of electrons thus forming the desired signal.

9. The method of operating a television pickup device wherein an optical image is formed on a photoelectric plate which comprises the steps of selecting electrons emitted from successive elementary areas of said plate, causing said selected electrons to liberate additional electrons by secondary emission, and causing said secondary electrons to initiate a television signal.

10. The method of operating a television pickup device wherein an optical image is formed on a photoelectric plate to cause electrons to be liberated therefrom which comprises scanning the image formed at said plate to select electrons emitted from successive elementary elements thereof, causing said selected electrons to liberate additional electrons by secondary emission, and causing said secondary electrons to initiate a television signal.

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