March 14, 1939. H. E. IVES 2,150,168

ELECTRO-OPTICAL SYSTEM

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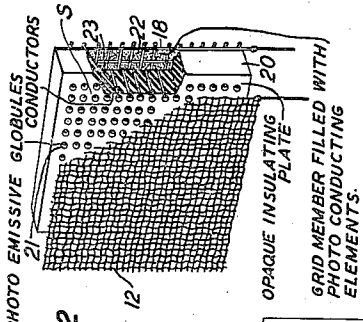


FIG. 2

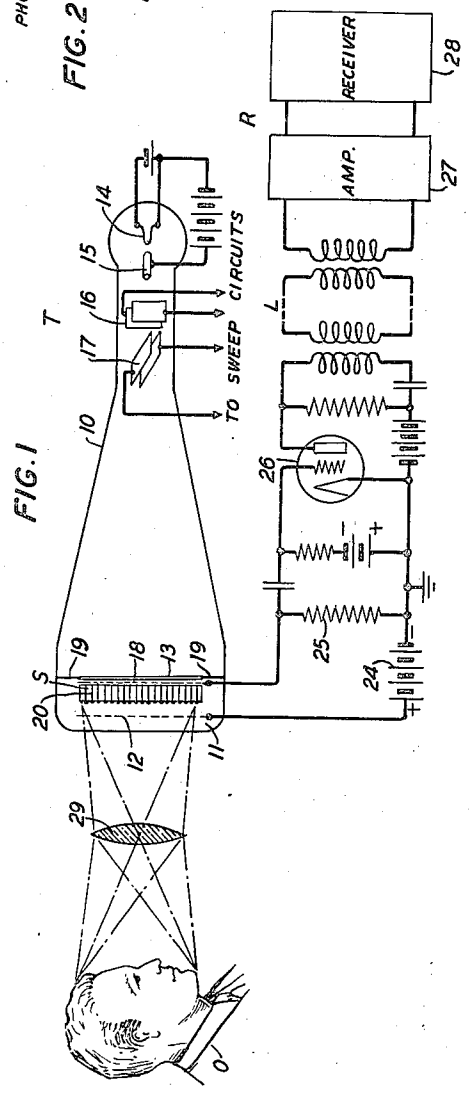


FIG. 1

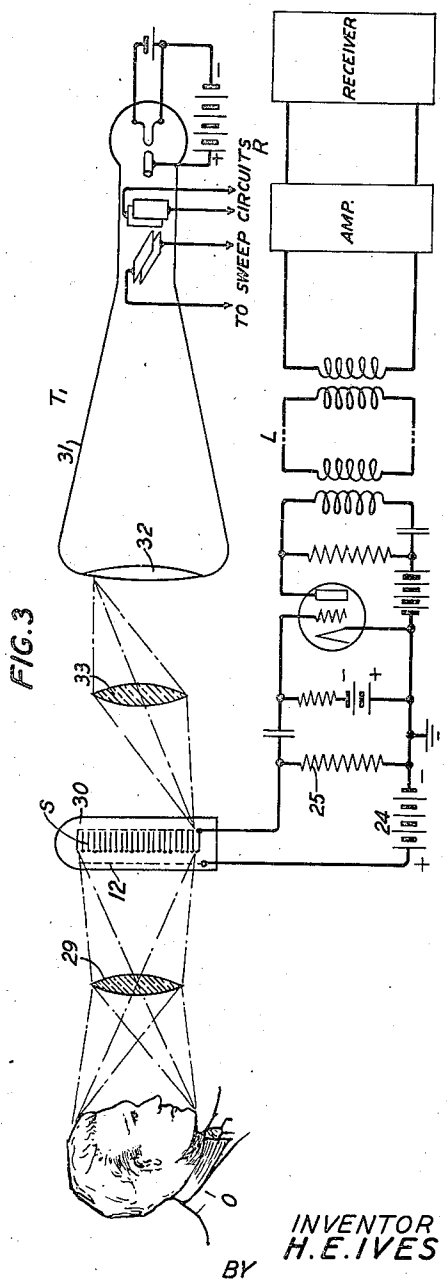


FIG. 3

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## ELECTRO-OPTICAL SYSTEM

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4 Claims. (Cl. 178—7.2)

This invention relates to electro-optical systems and more particularly to a means for setting up electric currents representative of the various light-tone values of an object, as in television scanning.

An object of this invention is to provide a novel means for translating light variations into electric current variations, as, for example, in the production of image currents in television systems.

Another object is to provide a television transmission system wherein novel means is provided for storing up the charges produced by radiations from each element of an object or field of view from one scanning period to the next.

These objects are accomplished in the preferred embodiment of this invention, which is hereinafter described in detail, by providing a target or screen upon which an image of an object to be televised is focussed by a suitable lens system and which target is scanned by a beam of light, which beam may be produced by the action of a cathode ray beam impinging upon a fluorescent screen. The target or screen preferably comprises a mosaic consisting of a number of elements, each element including a photo-emissive member connected to an elemental high resistance photo-conducting member. The photo-emissive and photo-conducting members are preferably separated by an opaque insulating material, such as colored glass, which is pierced by wires joining the photo-emissive members to the corresponding photo-conducting members. The radiations from the object directed upon the photo-emissive members cause these members to emit electrons to an anode, each photo-emissive member thus acquiring a positive charge, the amount of the charge depending upon the light-tone value of the corresponding elemental area of the object. Because of the high resistance of the corresponding photo-conducting members, these charges do not escape to the external circuit, the terminals of which are connected to the anode and the photo-conducting members. The moving beam of light scans successively the photo-conducting members making them conducting in turn. The charges escaping in turn to the external circuit form a succession of current pulses corresponding to the light-tone values of the elemental areas of the object or field of view.

Due to the fact that the photo-emissive members are illuminated continuously by radiations from the object, it is possible to store up on each member a large charge, which charge when allowed to escape to the external circuit produces a large current pulse. In order to prevent the charge from leaking off to the external circuit before the proper photo-conducting member is scanned, the photo-conducting members should be made of a material having high specific resistance in the dark.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof, in which:

Fig. 1 is a diagrammatic representation of a television system including the invention;

Fig. 2 is an enlarged perspective view of a portion of the system shown in Fig. 1; and

Fig. 3 shows a modification of the system of Fig. 1.

Referring more particularly to the drawing, the system of Fig. 1 comprises in general a television transmitting station T, suitable connecting media L, and a television receiving station R.

There is provided at the transmitting station T a cathode ray tube 10 having a gas-tight enclosure 11 located at one end thereof, in which is mounted a composite target or screen S and a mesh electrode 12. The target S is mounted on the wall 19 of the enclosure 11 carrying the fluorescent screen 13. Associated with the cathode ray tube is a suitable means for forming an image of an object or field of view O on the target S and means, such as the cathode ray beam of the cathode ray tube 10 impinging upon the fluorescent screen 13, for causing the target to be scanned with a beam of light.

The cathode ray tube 10 is provided with means, such as a cathode 14 and an anode 15, for producing a thin beam of electrons which is directed towards the fluorescent screen 13. The cathode beam of the tube 10 is deflected in two directions at right angles to each other and at such relative speeds in the two directions that the screen 13 is impinged upon by a moving pencil of electrons which moves across the screen in a series of parallel lines in a time interval within the period of persistence of vision. Deflection of the beam in the two directions is obtained in any desirable manner, such as by supplying the two pairs of deflecting plates 16 and 17 with currents of saw-toothed wave forms, the frequencies of these currents being such that the fluorescent screen 13 is completely scanned in a time interval within the period of persistence of vision. This moving pencil of electrons thus generates a moving beam of light which scans one surface of the composite target or screen S.

For a clearer understanding of the composi-

tion of the target or screen S, reference is made to Fig. 2 which shows an enlarged perspective view of the assembly within the enclosure 11 with the glass portions broken away. The target S comprises a mesh grid 18 of any suitable conducting material, such as nickel, which is preferably mounted on the end wall 19 of the cathode ray tube 10 adjacent the fluorescent screen 13, a large number of photo-conducting members 22 filling the interstices of the mesh grid 18, an opaque plate 20 of any suitable material such as dark glass and a large number of photo-emissive globules 21, corresponding in number to the photo-conducting elements 22, each elemental globule being joined through the glass plate 20 to its corresponding photo-conducting member 22 by an appropriate connection 23. The plate 20 is made opaque so that the light from the object will not strike the photo-conducting members 22. Associated with the target or screen S and adjacent thereto is an anode member 12 which may constitute a mesh grid of nickel or any other suitable material.

The anode member 12 is connected to the positive terminal of the battery 24 and the grid member 18 is connected to the negative terminal of the battery 24 through the resistance 25 which is connected in the input circuit of a suitable amplifier 26.

Associated with the enclosure 11 is an optical means for directing an image of an object or field of view O upon the target or screen S. The object or field of view O is illuminated by radiations from a suitable source (not shown) and radiations reflected from the object are gathered by an optical system, represented generally by the lens 29, and projected through the interstices of the anode 12 onto the photo-emissive surface of the target S.

The operation of the cathode ray tube 10 and its associated scanning device located at one end thereof may be better understood by considering the operation of a single element of the mosaic screen S. Light from the object falling on a photo-emissive globule 21 releases electrons which are attracted to the anode member 12. The elemental photo-emissive globule 21 is thus charged up to a positive potential, the value of the charge depending upon the intensity of the illumination. This charge does not escape because of the high resistance of the elemental photo-conducting member 22. At intervals of approximately one-twentieth of a second, the cathode ray beam of the cathode ray tube 10 is swept over an elemental area of the fluorescent screen 13, which, giving out light, causes the elemental photo-conducting member 22 to become conducting whereby the charge on the elemental photo-emissive member 21 is allowed to escape to the external circuit including the resistance 25, thus giving a current pulse to the input circuit of the amplifier 26. If the complete screen is considered, there is produced a succession of current pulses as the elemental photo-conducting members are scanned in turn, thus producing a television or image current.

The image current which flows through the resistance 25, after being raised to the desired power level by the device 26, which may comprise a multi-stage amplifier, is transmitted over suitable connecting means L to a remote station including a receiver R. In line carrier or radio transmission the amplified image current is used to modulate a carrier current of the proper frequency for transmission.

The receiving station R may comprise an amplifier 27, the output circuit of which includes the television receiver 28. Any suitable receiver for the purpose may be used. A satisfactory receiver utilizing a glow discharge lamp and a scanning disc is disclosed in U. S. Patent 1,723,122, September 10, 1929, to Horton. A suitable cathode ray tube receiver is disclosed in application Serial No. 466,067 of J. B. Johnson, filed July 7, 1930.

The image current flowing through the system of Fig. 1 will be quite large because the photo-emissive members 21 are illuminated continuously by radiations from the object. It is thus possible to store up a large charge which does not leak off to the external circuit until the scanning beam passes over the discharging photo-conducting member. In order to reduce the leakage through the photo-conducting members to a negligible amount, it is necessary to make them of a suitable photo-conducting material having a higher specific resistance in the dark than the ordinary selenium. The material should also have a quicker response than selenium. A material possessing both of these desirable properties is mercuric iodide ($HgI_2$), but my invention is not limited to the use of this material as any photo-conducting member possessing these properties can be used in its place. Any suitable photo-emissive material, such as potassium hydride, may be used for the globules 21.

In the modification shown in Fig. 3, the mosaic target S and the mesh anode 12 are mounted in an enclosure 30 which is adapted to be a separate unit from the cathode ray tube 31. The moving pencil of light generated by the fluorescent screen of the tube 31 is caused to scan the surface of the photo-conducting element by means of the optical system represented generally by lens 33. The description and operation of the system shown in Fig. 3 is otherwise similar to that described above with reference to Fig. 1. The target or screen S may be mounted on one wall of the enclosure 30 or it might be supported in the space between the walls. The anode 12 may take the form of a transparent metal layer mounted on one wall of the enclosure 30.

Other changes may be made without departing from the spirit of principles of the invention as hereinbefore expressed, the scope of which is defined by the appended claims.

What is claimed is:

1. An electro-optical system including a cathode ray tube comprising a cathode, an anode, a fluorescent screen, an assembly adjacent to and cooperating with said cathode ray tube comprising a composite target and a light transmitting anode, said target comprising a layer of discrete photo-conducting members of high specific resistance, a film of discrete photo-emissive members, and means for conductively connecting each photo-conducting member to its corresponding photo-emissive member, means for imaging an object field upon said photo-emissive members to cause emission of electrons from each photo-emissive member to the light transmitting anode to thereby impart a positive charge to each member in accordance with the light-tone value of the corresponding elemental area of an object or field of view, said photo-conducting members being of such high specific resistance in the dark that they act substantially as insulators when the light thereupon is weak to prevent passage of the charges through the photo-conducting members, means for preventing the photo-conducting members from being

exposed to radiations from the object, and said fluorescent screen being mounted closely adjacent and parallel to said layer of photo-conducting members to cause the light from said screen to render them conducting in turn each for a period very short compared to the period when said positive charge is accumulating so that said positive charges are successively caused to pass through the photo-conducting members to thereby control the flow of an image current.

2. An electro-optical system comprising an array of photo-emissive elements, means for simultaneously imparting charges to all of the various photo-emissive elements in accordance with the light-tone values of the corresponding elemental areas of an object or field of view, a photo-conducting element electrically connected to each photo-emissive element, a conducting member connected to all of the photo-conducting elements in common, said photo-conducting elements being of such high specific resistance in the dark that they act substantially as insulators when the light thereupon is weak to prevent leakage of the charges through the photo-conducting elements to the conducting member, and means for scanning said photo-conducting elements with a beam of light of sufficient intensity to allow the charges to pass through the photo-conducting elements to the conducting member to thereby set up an image current.

3. An electro-optical system comprising an array of photo-emissive elements, means for simultaneously imparting charges to all of the various photo-emissive elements in accordance with the light-tone values of the corresponding elemental areas of an object or field of view, a photo-conducting element electrically connected to each photo-emissive element, a conducting member connected to all of the photo-conducting elements in common, said photo-conducting elements being of such high specific resistance in the dark that they act substantially as insulators when the light thereupon is weak to prevent leakage of the charges through the photo-conducting elements to the conducting member, and means for scanning said photo-conducting elements with a beam of light of sufficient intensity to allow the charges to pass through the photo-conducting elements to the conducting member to thereby set up an image current, said conducting member comprising a mesh structure in the interstices of which the photo-conducting members are mounted.

4. An electro-optical system comprising an array of photo-emissive elements, means including an anode member towards which the electrons emitted from said photo-emissive layer are attracted for simultaneously imparting charges to all of the various photo-emissive elements in accordance with the light-tone values of the corresponding elemental areas of an object or field of view, a photo-conducting element electrically connected to each photo-emissive element, a conducting member connected to all of the photo-conducting elements in common, said photo-conducting elements being of such high specific resistance in the dark that they act substantially as insulators when the light thereupon is weak to prevent leakage of the charges through the photo-conducting elements to the conducting member, and means for scanning said photo-conducting elements with a beam of light of sufficient intensity to allow the charges to pass through the photo-conducting elements to the conducting member to thereby set up an image current.

HERBERT E. IVES.