

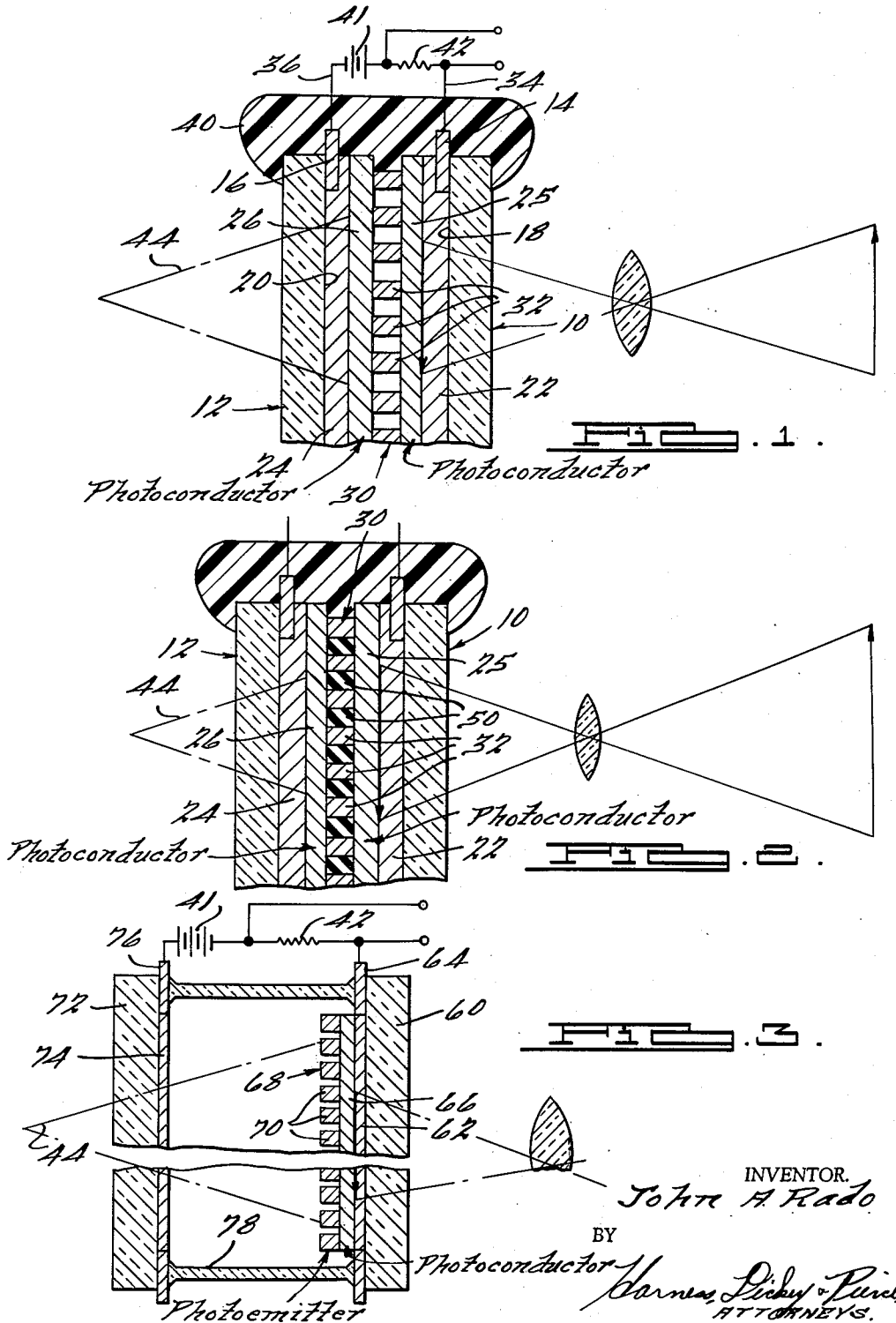
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J. A. RADO

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FLYING SPOT CAMERA TUBE

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INVENTOR.
JOHN A. RADO

BY
Barney Lichy & Paul
ATTORNEYS.

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FLYING SPOT CAMERA TUBE

John A. Rado, Lancaster, Ohio, assignor to Diamond Power Specialty Corporation, Lancaster, Ohio, a corporation of Ohio

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This invention pertains to an improved translating device for developing an electrical signal corresponding to a light image without the use of an electron beam.

One important object of the present invention is to provide an improved electronic camera device.

Another object is to provide an improved device for deriving an electrical signal from a light image, the device being of improved simplicity and ruggedness of construction.

Another object is to provide an improved device of the above-described character in which an electrical signal is developed by means of a flying spot of light.

Another object is to provide an improved device of this character including a screen for receiving a light image upon one face and means for developing a video signal representing the light image by scanning the reverse face of the screen with a light spot.

Another object is to provide an improved electrical camera device which does not require an evacuated envelope.

Another object is to provide an improved device of this character having a screen including two photoconductive films separated by a conductive mosaic, whereby electrical charges on the individual elements on the mosaic may be controlled by a light image projected upon one of the photoconductive films and also by a flying spot of light projected upon the other one of the photoconductive films in such a way as to generate a video signal.

Still another object is to provide an improved device of this character including a photoemissive film superimposed upon a photoconductive film whereby a video signal can be generated by projecting a light image upon the photoconductive film and by scanning the photoemissive film with a flying spot of light.

These and other objects and advantages of the present invention will become apparent in the following description of representative embodiments thereof taken in conjunction with the drawing wherein:

FIGURE 1 is a schematic cross-sectional view of a flying spot camera device according to a first embodiment of the invention;

FIG. 2 is a schematic cross-sectional view of a flying spot camera device generally similar to the device shown in FIG. 1 but including insulating material interposed between the conductive elements of the charge bearing mosaic; and

FIG. 3 is a schematic cross-sectional view of another embodiment of the invention incorporating a photoemissive film in place of the second photoconductive film shown in FIGS. 1 and 2.

A video camera device according to the present invention includes a screen having front and back light responsive surfaces, electrode means for making electrical contact to both of the surfaces, and electrical charge storage means disposed between the front and back surfaces for storing electrical charges in a mosaic-like pattern. A light image is projected upon the front surface of the screen, and the back surface is scanned by a flying spot of light. The front and back surfaces are maintained at different electrical potentials, so that current flows into and out of the storage means responsively to the light image and to the flying spot. The

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flying spot causes the storage means to become charged to a predetermined potential, and the charge leaks out of the storage means at a rate determined by the local area illumination provided by the light image. The amount of charging current is proportioned to the light image, and represents a video signal.

In the preferred embodiment, both the front and the back surfaces of the screen are constituted of photoconductive material, while in the alternative embodiment described herein, one of the surfaces is photoemissive and the other is photoconductive.

It will be appreciated that the drawing is not to scale and that certain portions thereof are greatly enlarged beyond their normal scale proportions in order to show clearly the various elements of the devices, which if they were shown according to scale would be difficult to discern.

Referring now to FIG. 1, a flying spot camera device according to a preferred embodiment of the invention is shown therein, and includes front and back face plates 10 and 12, respectively, which are transparent and may be made of glass. The face plates 10 and 12 are preferably of optical quality and are smoothly finished in order to minimize distortion. Bus bars 14 and 16, which may be of any desired highly conductive material, such as gold, silver or copper, for example, extend peripherally around the face plates 10 and 12, respectively, preferably on the inner surfaces 18 and 20 thereof. The bus bars contact transparent electrode films 22 and 24, respectively, which extend over the inner faces 18 and 20 of the two face plates. The electrode films 22 and 24 may be of any desired electrically conductive transparent material, and are preferably of the tin oxide type of the kind commercially designated by the trade name "Nesa" having a surface resistivity of less than 100 ohms per unit square.

Photoconductive films 25 and 26 are disposed upon the electrode films 22 and 24, respectively, and are spaced apart by a mosaic 30 composed of relatively small elements 32 of a metal such as silver. The photoconductive films 25 and 26 may be made of any desired photoconductive material, preferably one having a relatively high dark-to-light conductivity ratio such as, for example, arsenic selenide, antimony trisulfide, or semiconductive germanium or silicon. They are preferably relatively thick and may be, for example, one micron or greater in thickness in order to minimize the transmission of light through them, so that, for example, the light image projected upon the front photoconductive film 25 will not be transmitted to any large degree to the reverse photoconductive film 26. The actual thickness of the photoconductive films 25 and 26 will of course depend upon such factors as the intensity of illumination to be used, and the light transmission characteristics of the material of which they are made.

All of the films, including the mosaic film 30, may be successively applied upon either one of the two face plates 10 and 12, respectively, and the sandwich then completed by the application of the second face plate. Electrical leads 34 and 36 are connected to the bus bars 14 and 16, respectively, for connecting the device in an external circuit, and the device is sealed by the application of an insulating sealing material 40 around the edges of the sandwich. The nature of the sealing material 40 is not critical in the practice of the invention and in some cases it may be dispensed with altogether. Any desired clamping means may be provided for holding the sandwich together to insure against splitting. In the embodiment shown, the sealing material 40 performs this function, and secures the device against falling open.

In operation, a direct current voltage source, such as

the battery 41 illustrated, is connected in series with an output resistor 42 between the leads 34 and 36, thus establishing potential difference between the two electrode films 22 and 24. If now, the photoconductive films 25 and 26 are regarded as perfect insulators in the dark, no current flows in the circuit in the absence of a light signal. As the light beam, indicated at 44, scans the back photoconductive film 26, it causes successive elemental area portions of the photoconductive film 26 to become conductive, and thereby causes the mosaic elements 32 to become charged to the potential of the back electrode film 24.

Considering any one of the mosaic elements 32, after it has been charged and the scanning light beam has moved away from it, it discharges through the front photoconductive film 25 at a rate determined by the conductivity of the film 25 in the area immediately adjacent to mosaic element 32. The conductivity of each small area portion of the front photoconductive film 25 is determined by the amount of light falling upon it. During the interval, therefore, that the light beam 44 is absent from the vicinity of a particular element 32, the element discharges exponentially toward the potential of the front electrode film 22 at a rate dependent upon the illumination of the front photoconductive film 25 in the region thereof immediately adjacent to the mosaic element 32. The value of the charge remaining upon the element 32 at the time the light beam 44 next approaches it is therefore determined by the local illumination of the front photoconductive film 25, and the remaining charge determines the amount of current required to recharge the element 32 to the potential of the back electrode film 26 upon the succeeding scan of the light beam 44. The recharging current flows through the output resistor 42 and produces a video voltage pulse of a magnitude proportional to the illumination. The total video signal is made up of a succession of such pulses. An appropriate time constant is incorporated in the circuit to which the device is connected so that the video signal is not masked by the discharge current of the individual mosaic elements 32.

A modified form of the preferred embodiment of the invention is illustrated in FIG. 2, and is exactly similar to the form hereinabove described in connection with FIG. 1 except that the individual mosaic elements 32 are separated by an insulating network 50 instead of being air-spaced. The camera device shown in FIG. 2 may be made by first depositing the front transparent electrode film 22 and the front photoconductive film 25 upon the front face plate 10, and then placing a fine mesh glass screen upon or immediately adjacent to the front photoconductive film 25 and evaporating a conductive material such as silver through the screen and upon the photoconductive film 25 in sufficient quantity to fill up the interstices of the screen. After this is done, the conductive material that has been deposited upon the screen itself may be ground off, thereby isolating each little one of the mosaic elements 32 in a separate interstice in the screen. The back photoconductive film 26 and the back electrode film 24 are preferably deposited upon the mosaic 30, but alternatively they may be deposited on the back face plate 12, which is then pressed upon the mosaic, so that the back photoconductive film 26 makes contact with the individual elements 32 of the mosaic.

Alternatively, the mosaic 30 may be evaporated through a reticule (not shown) which is supported closely adjacent to the front photoconductive film 25, and then after the evaporation is completed and the individual mosaic elements 32 built up to a thickness at least equal to the thickness of the reticule, the conductive material which has been deposited upon the reticule itself may be removed by etching or the like and the reticule may then

be applied to the photoconductive layer, fitting itself over the individual, previously evaporated conductive elements 32.

The theory of operation of the device illustrated in FIG. 2 is exactly similar to the operation of the device shown in FIG. 1. Neither one of these devices requires an evacuated envelope or electron gun. They are extremely simple to manufacture, of rugged construction, and dependable in operation. A camera device according to another embodiment of the invention is shown in FIG. 3, and includes a front face plate 60, the inner surface of which is coated with a transparent electrode film 62. Contact with the electrode film 62 is made by a peripheral bus bar 64. A photoconductive film 66 is disposed upon the electrode film 62, and a photoemissive film 68 is disposed on top of the photoconductive film 66. The electrode film 62 may be of metal, or, preferably, of Nesa. The photoconductive film 62 may be of arsenic selenide, antimony trisulfide, or semiconductive germanium, or silicon as desired. The photoemissive film 68 may be of any desired photoemissive material and if its volume resistivity is relatively low, the film 68 is preferably made in mosaic form as shown. If, for example, the photoemissive film 68 is made of cesium-oxide-silver, it is made in a mosaic having relatively small elements 70 which are spaced apart slightly from each other, thereby providing the desired degree of volume resistivity and effectively insulating the separate elements from each other. If the resistivity of the photoemissive material is sufficiently high, the film 68 may be made continuous.

The back face plate 72 of the device is coated on its inner surface with a transparent, conductive electrode film 74, preferably of Nesa, and electrical contact is established with the film 74 by means of a bus bar 76 which extends peripherally around the back face plate 72. The front and back face plates 60 and 72 are sealed to opposite ends, respectively, of a cylindrical enclosure member 78, which is of an insulating material such as glass, and the interior of the chamber so formed is evacuated.

For operation, the device is connected in a circuit as shown including a direct current voltage source 41 and an output resistor 42 connected in series between the front and back bus bars 64 and 76, respectively. The voltage source 41 is connected in a direction to make the back electrode film 74 positive with respect to the front electrode film 62 so that photoelectrons emitted by the photoemissive film 68 are attracted toward and drift to the back electrode film 74 where they are collected. A light image is projected upon the photoconductive film 66, and a scanning light beam 44 is projected through the back face plate 72 upon the photoemissive film 68. When the light beam 44 strikes a given elemental area portion of the photoemissive film 68, that portion acquires a positive charge due to the photoemission of electrons therefrom. After the light beam departs, the charge decays by conduction through the photoconductive film 66 at a rate determined by the illumination falling upon the corresponding area portion of the photoconductive film 66. The current required to recharge the particular area portion of the photoemissive film 68 upon the next pass of the scanning light beam 44 produces a video voltage signal across the output resistor 42.

What is claimed is:

1. A photoelectric device for generating a video signal comprising a photoconductive film, means for projecting a light image upon said photoconductive film, a photoemissive film disposed upon and electrically in contact with one face of said photoconductive film, means for scanning said photoemissive film and for causing an emission of electrons therefrom, means for collecting photoemitted electrons from said photoemissive film, and a transparent electrode extending over the face of said photoconductive film opposite from said photoemissive film.

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2. An electrical camera device for generating a video signal comprising a photoconductive film, means for projecting a light image upon said photoconductive film, a photoemissive film disposed on said photoconductive film, means for scanning said photoemissive film and for causing an emission of electrons therefrom, means for collecting photoemitted electrons from said photoemissive film, and means for electrically contacting the surface of said photoconductive film opposite from said photoemissive film.

3. An electrical camera device for generating a video signal comprising a photoconductive film, means for projecting a light image upon said photoconductive film, a photoemissive film superimposed directly upon said photoconductive film and having a relatively high lateral resistance and a relatively low thickness resistance, means for scanning said photoemissive film and for causing an emission of electrons therefrom, means for collecting photoelectrons emitted by said photoemissive film, and electrical contact means for making area contact with the surface of said photoconductive film opposite from said photoemissive film.

4. An electrical camera device for producing a video signal responsively to the concurrent application thereto from opposite directions of a light image and a moving spot of light comprising a laminar structure including a photoconductive film having front and back surfaces and arranged to receive the light image upon its front surface, a transparent electrode disposed on the front surface of said film for making electrical contact therewith, a photoemissive film having relatively high lateral resistance and relatively low thickness resistance disposed on the back surface of said photoconductive film and arranged to be scanned by the moving spot of light, means for collecting photoelectrons emitted by said photoemissive film responsively to the moving light spot and thereby successively charging small area regions of said photoemissive film to a predetermined potential, and

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means for individually discharging the small area regions of said photoemissive film through said photoconductive film at a rate determined by the intensity of illumination of the light image projected upon said photoconductive film in separate portions thereof immediately adjoining the small area regions of said photoemissive film.

5. An electrical camera device for producing a video signal responsively to the concurrent application thereto from opposite directions of a light image and a moving spot of light comprising a laminar structure including a photoconductive film having front and back surfaces and arranged to receive the light image upon its front surface, a transparent electrode disposed on the front surface of said film for making electrical contact therewith, a photosensitive surface comprised of a mosaic of photoemissive elements disposed on the back surface of said photoconductive film and arranged to be scanned by the moving spot of light, means for collecting photoelectrons emitted by said photoemissive mosaic responsively to the moving light spot and thereby successively charging the areas by each of said photoemissive elements to a predetermined potential, and means for individually discharging said areas by each of said photoemissive elements at a rate determined by the intensity of illumination of the light image projected upon said photoconductive film in the area of each of said photoemissive elements.

6. The invention as claimed in claim 5 wherein said matrix of photoemissive elemental areas is a continuous photoemissive film.

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