

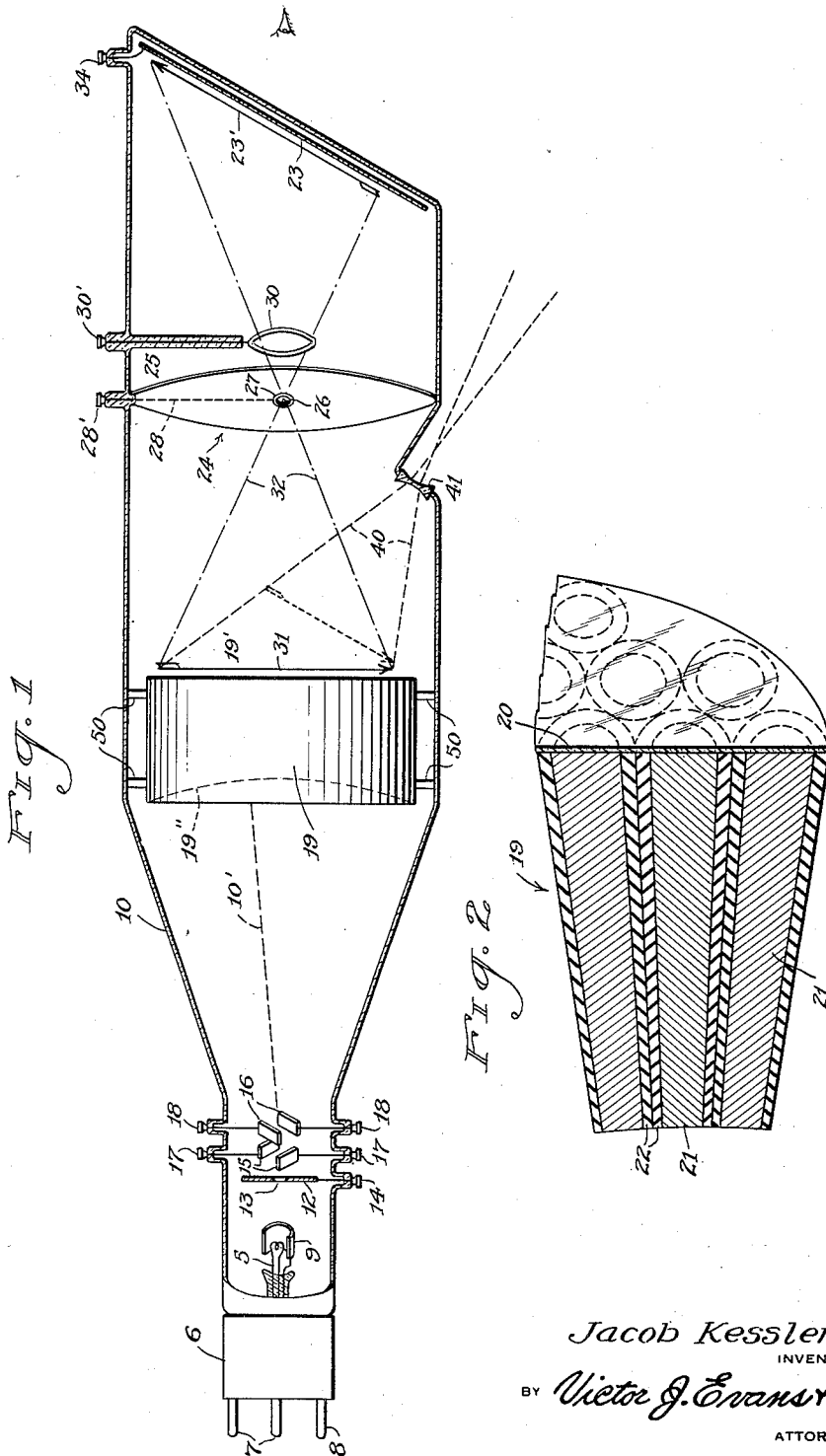
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PHOTOELECTRIC IMAGE CONVERTER

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PHOTOELECTRIC IMAGE CONVERTER

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2 Claims. (Cl. 250—150)

This invention relates to photo-electric image converters, and particularly to those of the cathode ray tube type.

It has heretofore been proposed to provide devices wherein an image of an object is focused upon a photo-electric surface, whereby to produce a corresponding electron-image, which image is then transferred, intact, to a fluorescent screen, thereby producing a visible image corresponding to the original light image, such as I propose in my co-pending United States application, Sr. No. 71,711, filed March 30, 1936, now Patent Number 2,091,862.

All these proposals, so far as I am aware, are capable of accomplishing their limited objects, but only within a particular and quite limited range of the spectrum, such as the infra-red only, or the ultra-violet only; and in most cases embody the further disadvantage that, in one way or another, the fluorescent screen is vitally interfered with by that member which is usually provided to focus the initial light image.

One of the principal objects of the present invention is to provide a unitary, single converter which will not require any auxiliaries or appendages, yet which will be adapted to convert all light images though they be formed of light from any part of the spectrum.

Another principal object of the invention is to provide a device of this character which will cast a complete electron image in successive order upon a suitable screen, in such a manner that no interference will be set up between the focusing member for the initial light image and said screen.

A further object of the invention is to provide an improved method, and novel steps, for converting an invisible image into a visible one.

The other objects and advantages of the invention will be made manifest as this specification proceeds.

The presently preferred embodiment of the invention is illustrated in the accompanying drawing, and described hereinbelow, by way of example only, and it is to be understood that the invention is limited in its embodiments only by the scope of the sub-joined claims.

In the drawing:

Fig. 1 is a longitudinal view of the article, partly broken away, partly in section, and partly in side elevation, and

Fig. 2 is a fragmentary longitudinal perspective section of a member of the tube.

The tube shown in the drawing somewhat resembles the tube disclosed in my co-pending application identified above, in that it comprises an incandescible filament 5 adapted to serve as the cathode ray source. The base 6 of the cathode ray tube has extending therefrom prongs 7 which serve as terminals for the filament 5

and a prong 8, which also projects from the base 6 is the terminal of a well-known Wehnelt control cylinder 9 which encircles the filament 5. A sealed bulb or envelope 10 is held in the base 6 and contains the parts to be hereinafter described, said bulb being evacuated of air and filled with an ionizable gas or gas mixture. The gas contained within the envelope 10 may be, for example, argon at a few millimeters of mercury pressure. An electrode 12 is positioned within the tube in front of the filament 5 and has a central aperture 13 thru which the cathode rays may pass. The electrode 12 has a terminal 14 positioned outside the envelope 10, as shown, and is adapted to be charged with a positive potential at, for example, three or four thousand volts, in order to give a high velocity to the cathode rays. Two pairs of deflector plates, 15 and 16, respectively, are contained within the bulb 10 in front of the electrode 12 and are positioned at right angles to each other. Each of the deflector plates 15 and 16 is provided with terminals 17 and 18, respectively, which terminals are exterior of the envelope or bulb 10. The deflector plates 15 and 16 and their operation in the cathode ray tube are well known to be for the purpose of deflecting a cathode ray so that it may be directed to predetermined positions when charged respectively to varying potentials, the varying potentials of each pair being out of phase with the other pair, as is well known. Spaced from, and positioned in front of, the deflector plates 15 and 16 and in the forward position of the envelope 10, is a commutator block 19 held in spaced relation to the wall of the tube by means of insulators 50. The commutator block 19 is of any desired shape and has a plain front face 19' and a concaved rear face 19'', upon which latter face the cathode rays fall. The concaved face 22 presents a spherical surface so formed that each of the rays will be normal at all times to the portion of the face on which it falls. The block 19 includes a plurality of straight electrical conductors 23 suitably insulated from each other and formed of any desired material, such for example as clean aluminum or copper wire, each wire being individually insulated from the other. It is to be understood, however, that the ends of the conductors or wires 23 are not insulated but are instead bare and exposed, and the forward ends, that is, those which lie in the forward face 19', constitute minute photo-electric surfaces.

In my previous invention these forward ends of the conductors 23 were devised to act as minute photo-electric surfaces sensitive only to invisible light, and in this instance the ends of these conductors were of the same metal as the conductors proper, that is, aluminum or copper. The forward ends of the conductors 21, that is, 80

those ends that lie in the forward face 19' of the commutator, were formed with concavities therein in order to receive, if desired, small masses of light sensitive material, such as sensitized sodium, or other material well adapted to emit electrons when acted on by light or other electromagnetic waves. These pieces of photo-electric material were separated from each other by the insulating material 22, which material surrounds each conductor or wire 21 in the commutator block.

An important component of the present invention resides in the preparation of a novel commutator block, in which preparation some difficulty is ordinarily encountered in insulating each photo-electric mass properly from the other. In the present invention, as an alternative to the use of a photo-electric surface made up of these minute masses, the insulated wire ends in the image face of the block are made up in such a manner as to closely contact a very thin layer of sensitized photo-electric material 20, the layer contacting same after the image face of the block has been smoothed into an almost completely plane surface. If the photo-electric layer laid upon the smooth surface of the image end of the block be made so thin as to approach molecular dimension in thickness, this layer will function in the same manner as the surface formed by the individual small masses lodged in the wire ends, as described above.

The invisible light image to be converted and brought from the quartz lens 41, upon this photo-electric surface 19' will induce a corresponding electron image which will be held on the photo-electric surface by accelerating-apertured anode 24. Also, a corresponding image consisting of positive charges will be brought to the front concave surface 19'' of the commutator block facing the cathode beam. The cathode beam scanning that surface will neutralize each quantity of positive charges at each wire-end facing the cathode beam in the block, in successive order. When the cathode beam has neutralized the positive charge at one wire end, a corresponding quantity of electrons will be released along the wire to the photo-electric layer at the image end of the same wire conductor and will pass to the photo-electric layer about the wire-end. A corresponding quantity of photo-electrons, under controllable conditions determined by the light intensity at that point, are emitted from the photo-electric surface and pass through the accelerating anode ring 27, and then to a fluorescent screen 23. If the photo-electric layer be thin, the neighboring photo-electrons of the photo-electric image will not be noticeably or appreciably affected.

The principle behind this construction is based on the fact that, while a thin photo-electric layer of molecular thickness is sufficient to produce the required photo-electric effect, the thin layer, unlike an exaggeratedly thick layer, does not constitute a path sufficiently conductive for the electrons coming from the cathode beam thru any one conductor or wire to the photo-electric layer in order to discharge or neutralize a wide range of the electron image about the terminal point of the wire in a photo-electric layer, which would thereby destroy the proper functioning of the whole block.

As illustrated in Fig. 2, the conducting wire ends of the commutator contact, in the improved form of the invention, with a thin film of photo-electric material 20, which film is completely transparent. Electrons passing in the wire from

the cathode beam will reach the photo-electric surface and spread radially from the wire to the positive charges induced by the light image falling upon that surface. With these positive particles neutralized, photo-electrons are ejected outwardly into space toward an accelerating ring anode 27, to be later described. Because of its very limited thickness, the photo-electric film does not form an electric conducting path sufficient for the cathode ray electrons to extend from one wire end thru the photo-electric film to the impressed positive particles about any neighboring wire end in the continuous, thin photo-electric film. The radial spread of the cathode beam electrons thru the photo-electric layer is only slightly larger than the diameter of the end of each wire.

The image ends of the insulated wires in the block form a supporting surface contacting the thin layer of photo-electric material, which surface is of a nature that no single metal base or insulator base can provide. Such a metal base would constitute a path of conduction for the electrons from the cathode beam at every point of the photo-electric surface and would result in releasing the entire electron image upon the photo-electric surface immediately. With a single metal base used, for example, the complete electron image would leave the photo-electric surface, streaming from every point of the surface whereon light falls. An insulator-base for the electric surface is inconceivable, according to the present invention, because the cathode beam electrons would not reach the photo-electric surface.

Thus the object of so constructing this commutator block is to provide more practical mode of making same than subsistent heretofore, and at the same time to allow for scanning every wire end or elemental area of the image individually and successively; however, if desired, it may be made as in my previous invention and yet function perfectly with members 24 and 30.

Within the enclosure, and a short distance in front of the commutator block 19 is a member 24 in the form of a disc, filling substantially the entire cross-section of the tube. It is fixed at one end by a terminal structure 28 and at the other end by any suitable means. The member 24 consists of a disc 25 made of suitable insulating material totally impervious to light. It has a central aperture, 26, and this aperture is lined with a thin metal ring 27, preferably of copper or some other common metal. The member 27 has a lead-in wire 28 running thru the interior of disc 25 to the terminal 28' which is connected to a source of high, steady, positive potential, thus constituting the member 24 an anode of high voltage. The disc 25, being composed of an insulating material, insulates the body of the lead-in wire 28, and thereby eliminates its tendency to accelerate the photo-electrons shortly after the tube has started up, and is completely functioning. This disc member 24 also prevents the light from the fluorescent image 23' on screen 23 from reaching the photo-electric surface 19' except thru the aperture bounded by the ring anode 27, whereby the fluorescent image is thrown back, or refocused back, upon the electron image, thereby causing each to add to the effect of the other.

It is to be understood that the fluorescent image 23' bears the same relation to the electron image as the light image in a pin-hole camera bears to the subject to which the camera film

is being exposed, except for the fact that here the fluorescent image is gradually formed piece by piece, that is, in successive order, and not all at once as in a pin-hole camera, and that the fluorescent image 23', therefore, is in inverted position to the electron image.

Behind the structure 24 and preferably not far away, as shown, is another anode, 30, here shown as in the form of a metallic ring. This ring is connected to a source 30' of relatively low potential, tho steady and positive during the time of operation. The anode 30 is an auxiliary anode serving principally to focus the fluorescent image. Its electrical object is to balance the straightening-out, or lineal, pull of the fluorescent screen 23 upon all electrons emanating from the electron image 19' passing thru ring anode 27.

The electrons coming from the electron image thru the aperture of the accelerating anode and thru the auxiliary ring anode, eventually impinge upon the fluorescent screen 23 so positioned as to produce a normal, undistorted fluorescent image, except that it is inverted relatively to the electron image. Since the lens 41 focusing the light image upon the photo-electric surface 19' is located at one side of the tube, the light image 31 will fall at an angle upon the photo-electric surface, thereby causing the light image and induced photo-electric image to be elongated in the upper part thereof, that is, near the arrow-tail, out of proportion with the lower part thereof, and this distortion will depend upon the angle of rotation peculiar to that particular lens, 41. The photo-electrons originating in the photo-electric material, wherever the light image falls upon the photo-electric surface, traverse the space between the block 19 and the screen 23, travelling, for all practical considerations, as straight lines 32, similar to the course of light from an object to its image upon a screen; in the present case, however, the object is the electron image and it is to be borne in mind that this latter image is the result of a distorted light image 31, due to the rays from 41 striking 19' obliquely. If the fluorescent screen is then displaced thru an angle equal to the displacement angle of the lens 41, this is, so that both lie in parallel, inclined planes and point in the same direction, the fluorescent image caused by the photo-electrons impinging upon the fluorescent screen one after the other to create an image, will be distorted by a like amount and in the opposite direction, since the fluorescent image is inverted in relation to the electron image 31, thus rendering a fluorescent image of the same form and proportions as the original subject, or initial light-image.

It is to be understood that the fluorescent screen 23 can be an ordinary fluorescent screen made up of the mineral Willemite, or of a mineral having similar fluorescent properties capable of conducting the electrons to the anode 34, to which the screen is connected.

It is to be observed that if an alkali-metal is employed as the photo-electric material in the ends of the members 21, the converter becomes capable of use for invisible light images from any part of the spectrum, as these metals are photo-electrically sensitive to the extreme infra-red rays as well as to the extreme ultra-violet rays. The image on the fluorescent screen 23 is in-

capable of reflecting scattered light, that is, of diffused light, to the photo-electric surface, which would obliterate the electron image when photo-electric material sensitive to visible light rays or to infra-red rays, is used. In the present tube, the fluorescent image is so formed that it can but intensify the electron image, inasmuch as the light emanating from the fluorescent image back to the photo-electric surface falls in congruent position with the original light image and its resultant electron image. The range of the light from the lens 41 is shown by the numeral 40. The lens 41 can be constructed and composed of any suitable material for directing the incident image onto the photo-electric surface.

As shown in the drawings, the naked eye may be employed unaided to view the converted image, 23'. Though this image is located on the other side of the Willemite screen and the eye is located external to the tube, yet the erect real image 23' can be easily and clearly seen because the tube wall is transparent and the fluorescent screen emits visible light rays. The eye can visualize the image when in any position, but it is preferable to have its optical axis lie perpendicular to the screen at a certain point on the other side of the screen, so that no distortion will be possible, and the image will stand out clear and erect in the space designated.

What is claimed as new is:

1. A cathode ray tube comprising, a source from which a cathode beam may emanate, a block of electrical conductors insulated from each other, said conductors at one end being exposed to said beam, deflecting means for scanning said beam, means for directing a light image from any part of the spectrum upon the other ends of said conductors, said other ends being photo-sensitized, a fluorescent member in the path of the photo-electrons ejected from said other ends, and an insulator and light impervious disc supported between said block of conductors and fluorescent member, said disc having a minute central aperture, a metallic ring lining said aperture and adapted to be charged to a high positive potential whereby said disc and ring focus the charge of electrons emanating from said block upon the fluorescent screen.

2. A cathode ray tube comprising a source from which a cathode beam may emanate, a block of electrical conductors insulated from each other, said conductors at one end being exposed to said beam, deflecting means for scanning said beam, means for directing a light image from any part of the spectrum upon the other ends of said conductors, said other ends being photo-sensitized, a fluorescent member in the path of the photo-electrons ejected from said other ends, an insulator and light impervious disc supported between said block of conductors and fluorescent member, said disc having a minute central aperture, a metallic ring lining said aperture and adapted to be charged to a high positive potential whereby said disc and ring focus the charge of electrons emanating from said other ends upon the fluorescent screen, and accessory electron focusing means supported between said disc and fluorescent screen.

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