

Aug. 12, 1969

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IMAGE-TRANSLATING DEVICE

3,461,340

Filed Jan. 27, 1965

FIG: 1

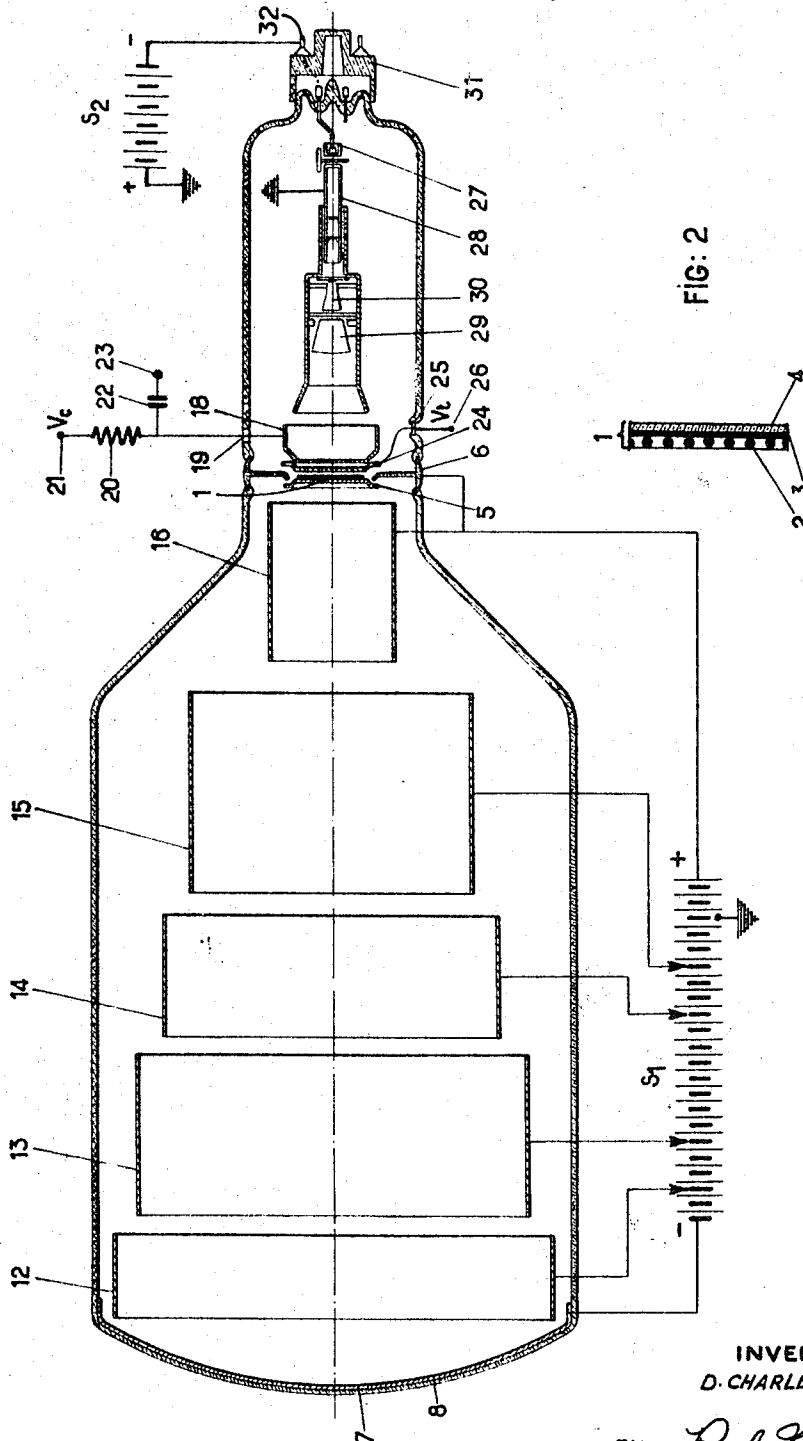


FIG: 2

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3,461,340

IMAGE-TRANSLATING DEVICE

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Filed Jan. 27, 1965, Ser. No. 428,350

Claims priority, application France, Jan. 31, 1964, 962,214

Int. Cl. H01j 31/48

U.S. Cl. 315—11

8 Claims

ABSTRACT OF THE DISCLOSURE

An image-translating device comprising a bombardment-induced conductivity target, on one side of the target a reading gun and on the other side a photo-cathode much larger than the target, and means for accelerating and focusing on the target an electron image provided by the photo-cathode, when exposed to a radiant image.

This invention relates to electron discharge devices in which a radiation image, received on an input screen, is converted into output signals which may be used to reconstruct the radiation image.

More particularly, the invention relates to pick-up tubes of the type in which the radiation image is converted by a photo cathode into a fast electron image, focused on a bombardment-induced conductivity target for producing thereon a charge pattern having a surface smaller than the surface of the photocathode, the charge pattern being scanned by a pencil-like beam of electrons for obtaining the output signals.

In this known type of pick-up tube the electrons of the scanning beam are slow and the output signals are picked up across a circuit connected to the conductive layer of the bombardment-induced conductivity target.

In a pick-up tube of the type specified, the present invention provides the improvement which consists in (1) accelerating the electrons of the scanning beam to a velocity sufficient to produce on the dielectric surface of the target a secondary electron emission with a coefficient $\delta > 1$, and (2) taking off the output signals on a collector electrode, positioned near the dielectric surface of the target and set at a direct current potential positive with respect to the conductive layer of the target.

It has been found experimentally that the above modifications result in a greatly increased sensitivity of the pick-up tube, thereby permitting the use of this type of tubes under considerably reduced illumination as compared with the illuminations that are usually required with the prior art tubes.

Accordingly, it is an object of the present invention to provide an image-translating device having greatly increased sensitivity compared to the known prior art devices.

Another object of the present invention resides in the provision of a pick-up tube operable with a bombardment-induced conductivity target which permits an enlargement of a portion of the image transmitted by the tube.

Another object of the present invention resides in the provision of a pick-up tube of the type described above which achieves all of the aforementioned aims with a structure that is simple and easy to adjust.

Still another object of the present invention resides in the provision of a pick-up tube of the type described above which permits easy adjustment of the desired extent of enlargement of the images to be transmitted by the tube.

These and further objects, features, and advantages of the present invention will become more obvious from the following description when taken in connection with the

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accompanying drawing which shows, for purposes of illustration only, one embodiment in accordance with the present invention, and wherein:

FIGURE 1 is a longitudinal cross-sectional view through one illustrative embodiment of a tube in accordance with the present invention, and

FIGURE 2 is a cross-sectional view, on a greatly enlarged scale, of a detail of the target used in the tube of FIGURE 1.

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, the tube illustrated in FIGURE 1 comprises an induced conductivity target 1 (seen on an enlarged scale in FIGURE 2), constituted in a well-known manner by a metallic grid 2, supporting a layer 3 of very slight thickness (about 0.1 micron) of metal such as aluminum, and covered with an insulating or dielectric layer 4, for example, of zinc sulfide, also very thin (of about 0.5–3 microns).

The target is fixed on a chassis 5, mounted on a ring 6 incorporated into the wall of the tube.

A photocathode 7 is disposed on a transparent glass support 8 at the extremity of the tube which faces the metallic grid of the target. The photocathode 7 is made of a material sensitive to the desired spectrum such as the visible spectrum, the infra-red spectrum, or the ultra-violet spectrum.

In the tubes intended to pick up images taken by X-rays or gamma rays, etc., the photocathode is covered additionally with a layer of substance which becomes luminescent under the radiations in question in such a manner as to transform these radiations into optical images within the visible spectrum.

The dimensions of the photocathode (height, width) are substantially greater than those of the target 1, for example, in a ratio of 6:1, which corresponds to a surface ratio of 36:1.

Cylindrical focusing and accelerating electrodes 12, 13, 14, 15, and 16 are disposed between the photocathode 7 and the target 1.

The electrode 16, connected to the target, is carried at a high potential (of the order of 25 kv.) with respect to the photocathode 7 by means of a voltage source S_1 , the same source furnishing also intermediate voltages, suitably chosen, to the electrodes 12, 13, 14, and 15.

Near the insulating face of the target 1 is disposed a collector in the form of a cylinder 18, connected across the passage 19 to a resistance 20 to which is applied through the terminal 21 an adjustable polarization voltage V_c , for example, between 10 and 80 positive volts. The collector 18 is connected on the other hand to a condenser 22 across which one takes off the output signals at 23.

A corrector ring 24, intended to improve the uniformity of the image, is disposed between the collector 18 and the target 1 as known in the art. The ring 24 is connected across the passage 25 to the terminal 26 which receives an adjustable voltage V_t , for example, between -20 and +20 volts with respect to the voltage V_c applied to the collector 18.

A reading system, facing the insulating layer of the target, comprises: an electron gun of conventional construction, comprising a cathode 27 and an anode 28, and which may also include all the necessary electrodes necessary for the focusing and control, not shown in detail as they are well known in the art, and a scanning device, for example an electrostatic scanning device including two deflection plates 29 and 30, conventional means (not shown) being provided to apply to these deflection plates suitable scanning voltages.

The different internal connections of the reading system terminate at the pins of the neck 31. Since the cathode 27 is connected to the pin 32, one connects the latter to the

negative terminal of a voltage source S_2 of the order of 1.5 to 2.5 kv., whose positive terminal is connected to ground. The anode 28, also connected to ground, thus finds itself at a positive potential with respect to the cathode 27. The sources for energizing the other electrodes of the reading gun (not shown) are conventional and utilize appropriate voltages as is known in the art.

Operation

The tube described above operates as follows:

In the absence of an image, the electron beam, issued from the cathode 27, accelerated by the anode 28 and deflected by the plates 29 and 30, scans the insulating face of the target 1. The accelerating voltage of the anode 28 being of the order of 1.5 to 2.5 kv., the electrons of the beam are sufficiently rapid to produce upon the impact on the target an emission of secondary electrons with a coefficient $\delta > 1$. The target thus loses more electrons than it receives, and it is charged positively, its insulating face taking on a positive potential which increases with the number of scans. As long as this positive potential remains lower than that of the collector 18, the secondary electrons move toward the collector 18. However, as the potential of the insulating face increases little by little, secondary electrons commence to fall back on the target. After a certain number of scans, there is established a state of equilibrium in which a constant current flows through the output 19 of the collector 18, and the insulating face of the target assumes uniformly a certain constant positive potential. The target is then a charged condenser.

If now one projects onto the photocathode 7, across the transparent support 8, an optical image of an object or of a scenery, taken either with visible light or not, or by X-rays or gamma rays, etc., the photocathode 7 emits electrons in the direction toward the target. These electrons are focused by the electrodes 12 to 16, and are accelerated by the voltage of the target, equal to that of the source S_1 , which is of the order of 25 kv. The accelerated electrons bombard the metallic face of the target, easily traverse the metallic layer 3 and penetrate into the insulating layer 4 where they provoke the phenomenon known under the name of induced conductivity.

By decomposing the condenser formed by the target into elementary condensers corresponding to the diverse points of the image, one sees that each elementary condenser is discharged owing to the induced conductivity. Now, the induced conductivity is proportional to the number of write-in electrons which bombard the plate of each elementary condenser, that is, to the light intensity of the corresponding point of the image. Each elementary condenser, therefore, is discharged by a quantity of electricity proportional to the corresponding light intensity. Since the potential of the metallic face of the target is fixed, there is formed on the insulating face of the target a charge pattern (electrostatic image) constituting a replica of the optical image projected onto the photocathode.

The continuation of the scanning of the insulating face by the reading beam produces the re-establishment of the initial positive potential, with emission toward the collector 18 of a quantity of secondary electrons more or less large depending on the scanned pattern. One thus introduces into the current of the collector variations which are transmitted by the condenser 22 to the output terminal 23 where one collects video signals available for the utilization.

If the ratios between the voltages of the electrodes 12, 13, 14 and 15 and those of the electrodes 16 (or of the target) are well chosen, all of the electrons issued from the photocathode 7 reach the target at the surface of which they thus arrive with a high energy due to the high value of the accelerating voltage, and with an increased density in the ratio of photocathode surface/target surface (equal to 36 in the described example). The electronic image projected on the target corresponds therefore to a much stronger light intensity than that of the initial optical

image. The writing system, comprising the photocathode 7 and the electrodes 12 to 16 therefore operate at the same time as brilliance amplifier modified in the sense that the usual luminescent screen on which appear in the brilliance intensifiers the images of amplified intensity, is suppressed and that, at the exact place of this suppressed screen, is disposed the target of FIGURE 1.

Thanks to this arrangement the sensitivity of the pick-up tube described is considerably increased in comparison with that of pick-up tubes of the same type, actually known, which permits to detect much weaker levels of illumination, all other things remaining the same.

It will also be appreciated that if for a certain adjustment of the voltages of the electrodes 12 to 15, the electrons issued from the entire surface of the photocathode 7 are focused on the target 1, one may also modify this adjustment in such a manner that only a portion of the electronic image issued from the photocathode 7 is focused on the target. The portion considered is then transmitted with an enlargement greater than that obtained with the transmission utilizing the entire surface of the photocathode. In other words, one may vary the enlargement of the images to be transmitted by causing to vary the adjustment of the voltages of the electrodes 12 to 15. With an experimental model, one has thus been able to cause the enlargement to vary within a ratio of 1:3.

While we have shown and described one embodiment in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to persons skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

We claim:

1. An image-translating device comprising a bombardment-induced conductivity target having a conductive layer and a dielectric layer, a photocathode having a surface greater than the surface of said target and adapted to convert a radiant image into a fast electron image, means for accelerating said electron image and focusing it on the conductive surface of said target for producing on said dielectric layer a charge pattern corresponding to said radiant image, means for producing a pencil-like beam of electrons scanning the dielectric surface of said target for discharging said charge pattern, thereby producing electrical signals representative of said radiant image, means for accelerating said scanning electron beam to a velocity sufficient to produce on the dielectric surface of said target a secondary electron emission with a coefficient $\delta > 1$, a collector electrode positioned near the dielectric surface of said target and set at a direct current potential positive with respect to the conductive layer of said target, and means for abstracting electrical output signals from said collector electrode.

2. An image-translating device comprising a bombardment induced conductivity target having a conductive layer and a dielectric layer, a photocathode having a surface greater than the surface of said target and adapted to convert radiant image into a fast electron image, means for accelerating said electron image and focusing it on the conductive surface of said target for producing on said dielectric layer a charge pattern corresponding to said radiant image, means for producing a pencil-like beam of electrons scanning the dielectric surface of said target for discharging said charge pattern and thereby producing electrical signals representative of said radiant image, means for accelerating said scanning electron beam to a velocity sufficient to produce on the dielectric surface of said target a secondary electron emission with a coefficient $\delta > 1$, a collector electrode positioned near the dielectric surface of said target and set at a direct current potential positive with respect to the conductive layer of said target, and means for abstracting electrical output

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signals from said collector electrode, said focusing means enabling to focus on said target the entire electron image.

3. An image-translating device comprising a bombardment induced conductivity target having a conductive layer and a dielectric layer, a photocathode having a surface greater than the surface of said target and adapted to convert radiant image into a fast electron image, means for accelerating said electron image and focusing it on the conductive surface of said target for producing on said dielectric layer a charge pattern corresponding to said radiant image, means for producing a pencil-like beam of electrons scanning the dielectric surface of said target for discharging said charge pattern and thereby producing electrical signals representative of said radiant image, means for accelerating said scanning electron beam to a velocity sufficient to produce on the dielectric surface of said target a secondary electron emission with a coefficient $\delta > 1$, a collector electrode positioned near the dielectric surface of said target and set at a direct current potential positive with respect to the conductive layer of said target, and means for abstracting electrical output signals from said collector electrode, said focusing means enabling to focus on said target only a portion of the area of the electron image.

4. An image-translating device comprising a bombardment induced conductivity target having a conductive layer and a dielectric layer, a photocathode having a surface greater than the surface of said target and adapted to convert radiant image into a fast electron image, means for accelerating said electron image and focusing it on the conductive surface of said target for producing on said dielectric layer a charge pattern corresponding to said radiant image, means for producing a pencil-like beam of electrons scanning the dielectric surface of said target for discharging said charge pattern and thereby producing electrical signals representative of said radiant image, means for accelerating said scanning electron beam to a velocity sufficient to produce on the dielectric surface of said target a secondary electron emission with a coefficient $\delta > 1$, a collector electrode positioned near the

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dielectric surface of said target and set at a direct current potential positive with respect to the conductive layer of said target, and means for abstracting electrical output signals from said collector electrode, said focusing means enabling to focus on said target only a portion of the area of the electron image and means for varying the focusing effect of said focusing means to thereby vary the size of said portion and obtain different enlargements.

5. An image-translating device as defined in claim 1 wherein said photocathode consists of a radiant energy responsive electron emissive surface positioned on the side of said target opposite said means for producing a beam of electrons.

6. An image-translating device as defined in claim 5 wherein the area of said photocathode is greater than the area of said target by a ratio of approximately 6 to 1.

7. An image-translating device as defined in claim 1 wherein said means for accelerating and focusing said electron image includes a plurality of electrodes spaced along the electron path from said photocathode to said target and an adjustable source of voltage connected to said electrodes for applying adjustable accelerating potentials thereto.

8. An image-translating device as defined in claim 1 wherein said target includes a conductive mesh facing said photocathode, a continuous conductive layer on the side of said mesh opposite from said photocathode and a continuous insulating layer on said conductive layer.

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U.S. Cl. X.R.

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