Aug. 4, 1942. P. T. FARNSWORTH 2,292,111

IMAGE DISSECTOR

Filed Sept. 7, 1940 2 Sheets-Sheet 1

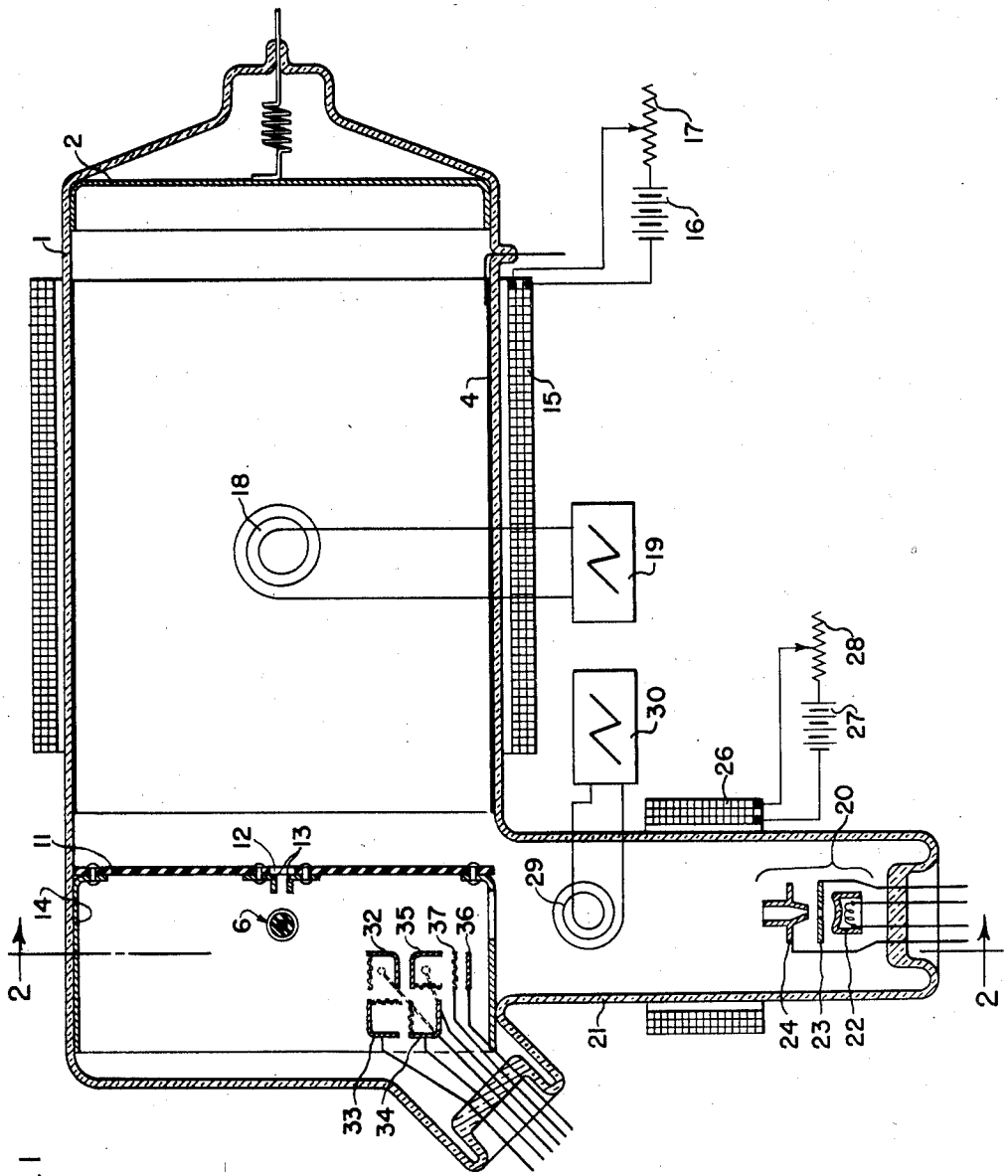



FIG. 1

INVENTOR
PHILO T. FARNSWORTH
BY Edwin D. Martin
ATTORNEY

Aug. 4, 1942. P. T. FARNSWORTH 2,292,111

IMAGE DISSECTOR

Filed Sept. 7, 1940 2 Sheets-Sheet 2

FIG. 2

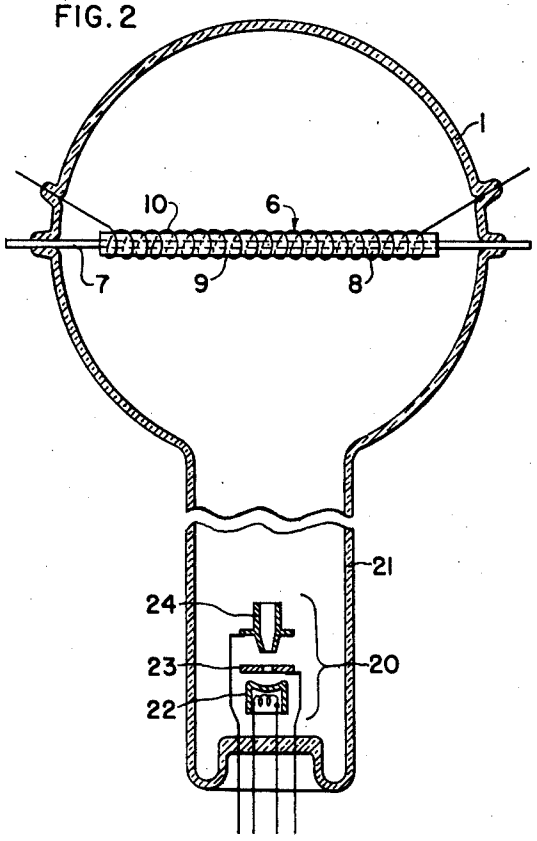



FIG. 3

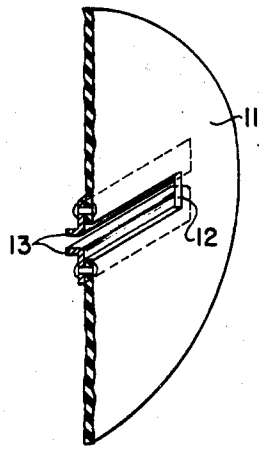
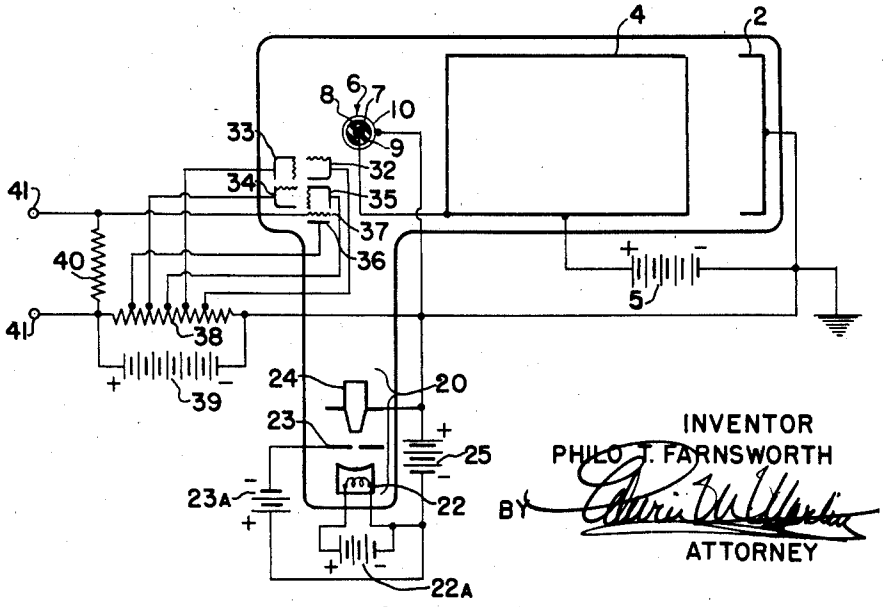



FIG. 4




INVENTOR
PHILO T. FARNSWORTH
BY
ATTORNEY

Patented Aug. 4, 1942

2,292,111

# UNITED STATES PATENT OFFICE

2,292,111

## IMAGE DISSECTOR

Philo T. Farnsworth, Fort Wayne, Ind., assignor to Farnsworth Television and Radio Corporation, a corporation of Delaware

Application September 7, 1940, Serial No. 355,706

1 Claim. (Cl. 250—150)

This invention relates to television picture signal generating tubes and particularly to tubes of this type which are capable of storing, over an appreciable interval of time, electrical charges corresponding to the illumination of an optical image.

Such tubes usually comprise a mosaic of mutually insulated photoelectric elements deposited upon a layer of insulating material backed by a metallic layer, commonly referred to as the "signal plate." In the operation of such tubes, an optical image of the object to be transmitted is focused upon the mosaic in order to develop an electrical charge image corresponding to the optical image. A picture signal is caused to be generated across a resistor operably connected to the signal plate by scanning the charge image with an electron beam.

Similar tubes have been devised having a continuous photoelectric cathode upon which an optical image is focused. A layer of insulating material backed by a signal plate or signal electrode is provided, upon which at least a portion of the photoelectric emission is focused in image relation, thereby to develop a charge image. Here, again, the picture signal is generated by scanning the charge image by means of an electron beam.

A tube of the latter type is described in U. S. Patent No. 2,100,842, issued November 30, 1937, to Philo T. Farnsworth. In accordance with one mode of operation of the tube described therein, photoelectrons are directed in image relation upon the surface of an insulating layer with a velocity insufficient to liberate secondary electrons therefrom, whereby the insulating surface accumulates negative charges in image relation. The insulating surface is scanned by an electron beam having sufficient velocity to liberate secondary electrons therefrom and thereby to neutralize the negative charges. Due to the change in charge on the insulating surface, an electron current flows from the signal electrode backing the insulating surface to this surface. This electron current also flows through a resistor connected to the signal electrode and produces a voltage drop thereacross representing the picture signal.

A disadvantage of tubes having charge storage members which are scanned on the same side on which the charge image is developed, such as have heretofore been employed, is that there is established a blocking potential near the surface of the storage member which prevents the collection of the entire secondary emission from the insulating surface. This prevents the insulating surface from obtaining as high a positive potential, upon being scanned, as would be desirable for best operation of such tubes.

It is an object of the present invention to provide an improved television picture signal generating tube which does not have the disadvantage above referred to.

In accordance with the present invention, there is provided a television picture signal generating tube comprising a photoelectric cathode adapted to have an optical image focused thereon and an electron gun for developing a beam of electrons. There is also provided an electrode having an insulating surface adapted to receive photoelectrons from the photoelectric cathode and also adapted to be scanned by the beam of electrons. There is further provided an electron-permeable electrode which is positioned contiguous to the insulating surface serving effectively to adjust the equilibrium potential to which the insulating surface can be charged to desirable value, and means for collecting electrons emitted by this surface.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claim.

In the accompanying drawings:

Fig. 1 schematically illustrates a longitudinal cross section through a picture signal generating tube embodying the present invention;

Fig. 2 shows a cross section through the tube of Fig. 1 along the line 2—2;

Fig. 3 shows a section of the scanning slot in perspective view; and

Fig. 4 is a diagram showing the tube of Fig. 1 and its operating circuit.

Referring now more particularly to Fig. 1, there is provided an evacuated envelope 1 housing a photoelectric cathode 2 upon which an optical image may be focused by means of a lens 3. For acceleration of the photoemission from the cathode 2, there is provided an anode 4, preferably consisting of a metallic wall coating and adapted to be held at a positive potential with respect to the cathode 2.

A storage member 6 is provided which is adapted to receive photoelectrons emitted from the cathode 2 and comprises a metallic wire 7, an insulating body 8 having an outer surface 9 surrounding the wire, and an accelerating electrode 10 comprising a thin wire spirally wound upon the insulating surface 9, as shown in detail in

Fig. 2, the individual turns thereof being spaced from each other by a distance preferably ten times greater than the wire diameter. The storage member 6 is supported by the wire 7 sealed at opposite ends to the envelope 1.

In order that electron emission from the cathode 2, representing only one line of the image, will impinge the storage member 6 at any given instant, there is provided a mica disc 11 having a slot 12 and carrying slot-defining members 13, as shown. The mica disc 11 is preferably supported by a metallic ring 14 fitting closely into the interior of the envelope 1.

In order to focus the photoelectric emission from the cathode 2 in image relation on the charge storage member 6, there is provided a focusing coil 15 arranged around the envelope 1, as shown, and a battery 16 together with an adjustable resistor 17, which are connected in series therewith for providing operating voltage therefor in conventional manner.

For the purpose of developing a magnetic deflecting field for vertical deflection of the electron image at frame frequency, there is provided an arrangement of scanning coils, schematically indicated at 18, connected to a suitable source of deflecting current 19, as shown.

For the purpose of scanning with an electron beam the surface 9 of the insulating body 8, there is provided an electron gun 20 housed in a protrusion 21 of the envelope 1 and comprising an indirectly heated cathode 22, a control element 23, and an anode 24.

In order to focus the electron beam developed by the electron gun 20, there is provided a focusing coil 26 surrounding the protrusion 21 and connected in series relation with a voltage source or battery 27 and an adjustable resistor 28, as shown. There is also provided a deflecting coil arrangement schematically indicated at 29 and connected to a suitable source of deflecting current 30 to deflect the electron beam across the storage member 6 at line-scanning frequency.

In order to collect secondary electrons liberated from the insulating surface 9 and to multiply, collect, and convert these electrons into a picture signal voltage, there is provided an electron multiplier of the type described in U. S. Patent No. 2,163,966, issued June 27, 1939, comprising a plurality of secondary-emitting electrodes 32, 33, 34, 35, 36 and an electron collector 37.

Fig. 2 shows the elongated shape of the storage member 6 and its support by means of the ends of the wire 7 sealed into the envelope 1, and Fig. 3 shows an enlarged perspective view of the transparent mica disc 11 and the slot 12 with slot-defining members 13.

Referring now more particularly to Fig. 4, there is here shown the tube of Fig. 1 connected in circuit for operation. For the purpose of accelerating the photoelectric emission from the cathode 2 toward the storage member 6, there is provided a suitable voltage source or battery 5 having its negative terminal connected to the cathode 2 and its positive terminal connected to the anode 4 and the metallic wire 7 of the storage member 6. Operating voltage is supplied to the anode 24 of the electron gun 20 by means of a suitable voltage source or battery 25, whose positive terminal is also connected to the accelerating electrode 10, in order thereby to establish a datum level for the most positive potential to which the insulating surface 9 may be charged. A filament battery 22A may be provided to heat the cathode 20, and a bias battery 23A may be connected between the cathode 22 and the control member 23 to provide a suitable operating bias, as shown.

The secondary emitting electrodes 32, 33, 34, 35, and 36 of the electron multiplier are connected to suitable taps of a voltage divider 38 connected across the terminals of a voltage supply or battery 39A for the purpose of maintaining these electrodes at increasingly positive potentials. The electron collector 37 is connected by way of an output resistor 40, across which the television picture signals are developed, to the positive terminal of the battery 39. For the purpose of deriving the picture signal, the resistor 40 is provided at its ends with a pair of output terminals 41, 41.

In operation, an optical image of the object to be transmitted is focused upon the cathode 2. The emission therefrom is focused in image relation in the direction of the disc 11 by means of an axial magnetic focusing field developed by the focusing coil 15, and is deflected at frame-scanning frequency by means of a magnetic deflecting field developed by the deflecting coil arrangement 18. Electrons corresponding to a single line of the image to be transmitted pass through the slot opening 12 defined by members 13 and impinge upon the surface 9 of insulating member 8 with a low velocity and thereby develop negative charges upon that surface. The surface 9 is scanned at line frequency by means of the electron beam generated by the electron gun 20. The eletcrons of this beam have a velocity sufficient to liberate secondary electrons from the insulating surface upon impact therewith. Due to the loss of secondary electrons, the negative charges developed on the insulating surface 9 are neutralized and the surface brought to a positive potential of such value that the ratio of primary scanning beam electrons and secondary electrons is unity, which condition is commonly referred to in the art as the "equilibrium." More or fewer secondary electrons are released upon impact of the scanning beam with the insulating surface 9 in accordance with the negative charges thereon, and are drawn into the electron multiplier comprising the secondary emitting electrodes 32, 33, 34, 35, and 36 and electron collector 37. The multiplier electron current develops a voltage drop across the resistor 40 which represents the picture signal.

As can be understood from above, the accelerating electrode 10, in the shape of a thin wire wound about the insulating surface 9, is a particularly suitable expedient for establishing a fixed positive potential at which the equilibrium condition is reached.

Obviously, any other suitable type of electron multiplier may be utilized or the electron multiplier may be entirely omitted, a suitable amplifier being provided outside of the tube.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

A television picture signal generating tube comprising a photoelectric cathode adapted to have an optical image focused thereon, an electron gun

for developing a beam of electrons, an elongated electrode having an insulating surface adapted to receive photoelectrons from said cathode and adapted to be scanned by said beam of electrons, means transparent to light but non-permeable to electrons, having an elongated aperture for permitting only photoelectrons emitted from a linear portion of said photoelectric cathode from reaching said insulating surface at any given instant, an electrode adjacent said insulating surface, and means for collecting electrons emitted by said insulating surface.

PHILO T. FARNSWORTH.