Dec. 9, 1958 | R. W. SMITH | 2,864,031

ELECTRICAL STORAGE TUBE

Filed Dec. 30, 1950

Fig_1

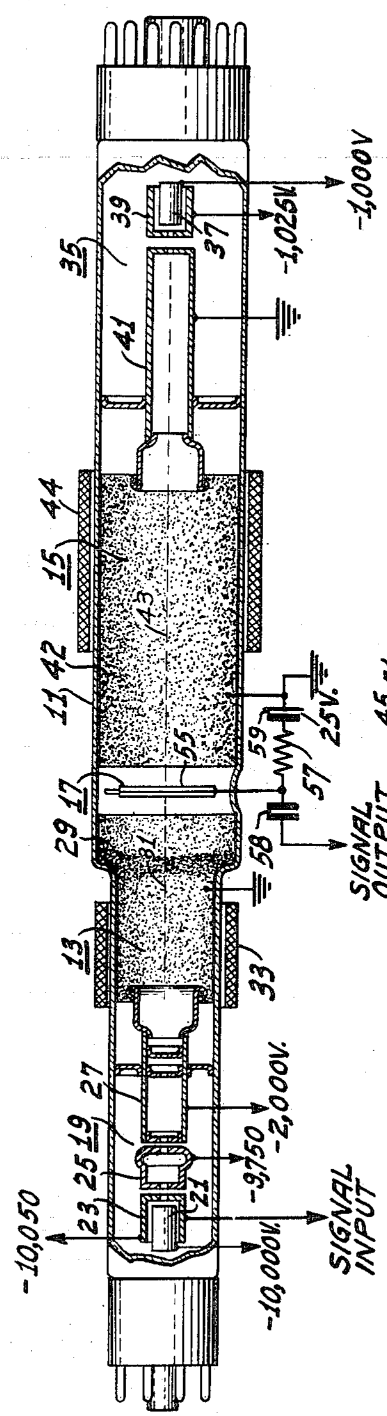
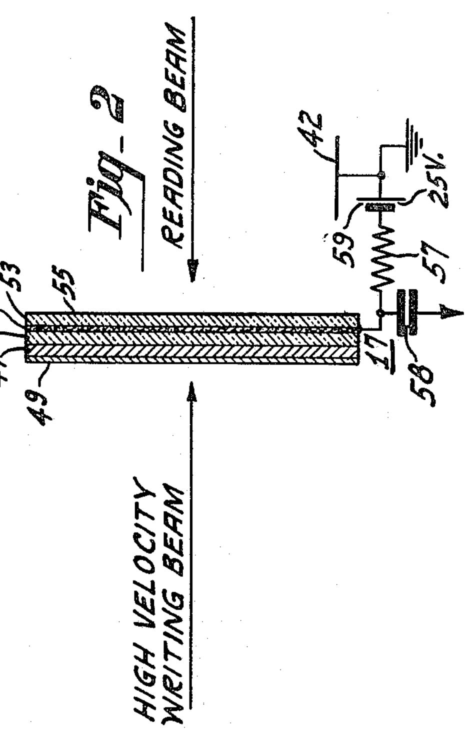


Fig_2



INVENTOR
Roland W. Smith
BY
William A. Zalesak
ATTORNEY

United States Patent Office

2,864,031

Patented Dec. 9, 1958

2,864,031

ELECTRICAL STORAGE TUBE

Roland Wright Smith, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application December 30, 1950, Serial No. 203,705

5 Claims. (Cl. 315—12)

This invention relates to improvements in electrical storage tubes of the type wherein information is laid down by the action of a cathode ray beam upon one side of a two-sided storage electrode and is taken off by the action of another cathode ray beam upon the other side of the same electrode. In particular, it is concerned with an improved storage electrode for use in such tubes.

L. Pensak in co-pending U. S. application 29,746, filed May 28, 1948, now abandoned, disclosed an electrical storage tube wherein two independent cathode ray beams bombard separate sides of a two-sided target electrode. This target, or storage electrode, comprises a conductive signal plate covered by a layer of insulating material which becomes electrically conductive in the area of impact when struck by electrons having sufficient velocity. In the operation of the tube, a low velocity electron beam of the order of 1000 volts bombards the surface of the insulating material and causes secondary emission of electrons therefrom. This loss of electrons results in static charges between the surface of the insulating material and the conductive signal plate. A high velocity electron beam (about 10,000 volts) which is the "writing" beam penetrates into the insulating material making it conductive and discharging the potential between the insulating material surface and the conductive plate. When the low velocity or "reading" beam again charges up the surface of the insulating material, there is a signal current through an output circuit connected to the conductive plate. It has been found, however, that repeated high velocity electron bombardment and penetration of this insulating material causes changes in its physical characteristics which show up as undesirable signals or "noise" in the tube output. This is particularly noticeable when a steady signal (e. g. range markers) has been stored in a given area. When this particular signal is no longer desired, and after it is no longer included in the signal input to the tube, there still remains a certain amount of spurious signal output resulting from the effect of the previous steady bombardment of the storage electrode.

Accordingly, it is an object of the present invention to provide a storage tube having a longer life and more stable characteristics.

Another object is to provide an improved storage electrode and one characterized by its ability to resist deterioration when subjected to prolonged bombardment by an electron beam.

Another object is to provide a "noise-free" storage tube, and one which shall utilize lower operating voltages than storage tubes of the same general dimensions.

The improved storage electrode of the present invention, in a preferred embodiment, comprises a supporting layer of light-transparent material coated on one side with an electron-sensitive, light-emissive, phosphor and on the other side with a light-transparent conductive coating and a layer of photo-conductive material.

Bombardment of the surface of the photo-conductor by a first electron beam results in secondary emission from the conductor and charges of potential difference between the surface bombarded and the conductive coating. When the phosphor is excited by a second electron beam, it emits light and this light, by rendering the photo-conductor conductive, discharges the potential stored between the conductive coating and the surface of the photo-conductor in the immediate area of excitation.

Restoration of the charge by the first electron beam causes a current in the circuitry associated with the conductive coating and photo-conductor, and provides an output signal.

The invention is explained in more detail by reference to the drawing in which:

Fig. 1 is a longitudinal section of an electrical storage tube embodying the invention;

Fig. 2 is an enlarged view in section of the storage electrode of Fig. 1.

The tube of Fig. 1 comprises a substantially cylindrical glass envelope **11** containing a continuous evacuated space divided into a "writing" chamber **13** and a "reading" chamber **15** by a two-sided storage electrode or target **17** which is situated at the approximate center of the cylindrical envelope **11** and normal to its longitudinal axis.

At the end of the "writing" chamber **13** remote from target **17** is a high velocity electron gun **19** comprising a cathode **21**, a control electrode **23**, a screen grid **25** and a focusing anode **27**. The interior surface of the glass envelope **11** in the region between the focusing anode **27** and the storage electrode **17** is coated with an electrically conductive substance **29** such as aquadag and serves as a second focusing and accelerating anode. The gun **19** is positioned axially of the chamber **13** so that its electron beam **31** (referred to as the "writing" beam **31**) will follow a path transverse to the storage electrode **17**. On the outer surface of the chamber **13** and in the region where the electron beam **31** emerges from the focusing anode **27** or deflecting coils **33** which cause the beam **31** to scan an image raster upon the storage electrode or "target" **17**.

At the end of the "reading" chamber **15**, remote from the storage electrode **17**, is an electron gun **35** comprising a cathode **37**, a control electrode **39** and an accelerating and focusing electrode **41**. The interior surface of the reading chamber **15** in the region between the accelerating anode **41** and the storage electrode **17** is coated with an electrically conductive substance **42**, such as aquadag, similar to the coating **29** in the writing chamber **13**. The coating **42** is maintained at the same potential as the anode **41**, and does not accelerate the electrons from the gun **35**, but serves as a collector for secondary-electrons from the reading surface of the target **17**. The gun **35** is positioned along the longitudinal axis of the chamber **15** so that its electron beam **43** (referred to as the "reading" beam **43**) impinges upon the reading surface of the storage electrode **17**. Deflecting coils **44** cause the electron beam **43** to scan an image raster upon said surface.

As shown more clearly in Fig. 2, the storage electrode **17** comprises a foundation plate **45** constituted of glass or equivalent transparent or translucent material (e. g. mica). The "writing side" of this transparent plate **45** supports an electron-sensitive, light-emitting, phosphor material **47** covered by an aluminum film **49**. The other or "reading" surface of the transparent plate **45** is coated with a thin, semi-transparent conductive coating **51** and a layer of photo-conductive material **53**.

In the operation of the tube, the "reading" beam **43** from the gun **35** in the reading chamber **15** bombards the surface **55** of the photo-conductive layer **53**. Secondary electrons are emitted from the surface **55** and are collected upon the conductive coating **42** until surface **55** and coating **42** are brought to approximately the same potential. This equalizing of potential takes place because the negative electrons which are freed from the surface **55** are attracted to the more positive coating **42** until the surface **55** loses so many electrons that it reaches the same positive potential as coating **42**. This produces an electrostatic charge or potential difference between the surface **55** and the thin conductive coating **51**. The surface 55 and the conductive coating 51 act like the charged plates of a condenser with the main body of the photo-conductive material 53 insulating them from each other.

Electrical currents flowing through the deflection coils 33 cause the electron beam from the "writing" gun 19 to scan an image raster upon the writing surface of the storage electrode 17. This beam is of a high velocity and penetrates through the aluminum film 49 to excite the phosphor material 47. The phosphor in the area of electron impact emits light in accordance with signal input voltages applied to the control grid 23 of the writing gun 19. The light emanating from the phosphor 47 passes through the transparent foundation plate 45 and through the transparent conductive coating 51 thereon. The light reaching the photo-conductive layer 53 renders said layer conductive in the immediate area of excitation. As a consequence, a conductive path is established in particular areas for discharging the electrostatic charges between the conductive coating 51 and the surface 55 of the photo-conductive layer 53. The discharged areas of the surface 55 remain in that condition until recharged by the reading beam 43. Because of the insulating qualities of the photo-conductor 53 the discharged areas of the surface 55 are not affected by the charge present between the conductive layer 53 and other areas of the surface 55 of the photo-conductor 53.

When the reading beam 43 scans the previously discharged areas, it recharges the surface 55 of the insulating material 53 to the potential of the conductive coating 42, in the manner described above for the original charging. This charging of the surface 55 to a positive potential with respect to the conductive coating 51 causes an electron flow from the battery 59 through an output resistance 57 to the conductive coating 51. The voltage variations across the resistance 57 become a signal output through the condenser 58. Since there will be some current through the resistance 57 during the writing cycle when the writing beam 31 excites the phosphor 47 and causes a discharge between the surface 55 through the photo-conductor 53 to the conductive layer 51, an appropriate frequency separation circuit (not shown) may be employed to make the output circuit sensitive to only the reading beam. This type of circuit is well known in the storage tube art and is explained by L. Pensak in an article entitled "The Graphichon—A Picture Storage Tube" published in the RCA Review for March 1949, cf. p. 67 ff.

In this manner, an electrical signal imposed upon the storage or target electrode 17 through the agency of the writing beam 31 can be stored on the electrode 17 until it is desired to remove the signal by the action of the reading beam 43.

In the selection of materials for the phosphor layer 47 and the photo-conductive layer 53, care should be taken that the spectral emission of the phosphor corresponds to the spectral sensitivity of the photo-conductor. With these requirements in mind, it is suggested that the phosphor layer 47 consist of blue-emitting zinc sulfide and the photo-conductive layer 53 of evaporated zinc sulfide.

The function of the aluminum film is explained in an article by D. W. Epstein and L. Pensak in the RCA Review for March 1946, page 5, entitled "Improved Cathode Ray Tubes With Metal-Backed Luminescent Screens." Among other things it results in reflection of the light produced by the phosphor toward the photo-conductor with a consequent increase in efficiency.

The tube is shown in Fig. 1 with the writing beam 31 operating at 10,000 volts. This is the same voltage as employed in the Pensak storage tube referred to above. Such high voltage on the writing beam is not necessary, however, with the improved storage electrode of the present invention. The writing beam does not require the high velocity necessary for penetration of the insulating layer as in the Pensak construction. Sufficient velocity

to excite the phosphors is all that is necessary. Satisfactory results have been secured with a writing beam as low as 1,000 volts.

Likewise, since the electron beam need not penetrate into the target to make it conductive, the structure described eliminates spurious signals or "noise" resulting from physical deterioration of the storage electrode due to continuous bombardment, and provides a storage tube with a longer life.

What is claimed is:

1. A cathode ray device comprising an evacuated envelope containing a storage electrode which comprises a phosphor layer, a photo-conductive layer, and an interposed light-transparent electrically conductive layer; a first source of electrons for exciting said phosphor material in accordance with an input signal to cause said phosphor material to emit light upon said photo-conductive material; and a second source of electrons for creating an electrical charge between a surface of said photo-conductive material and said electrical conductor when said phosphor is not emitting light.

2. A storage tube comprising an evacuated envelope containing an electrode having a translucent base of insulating material, a layer of electron-sensitive light emitting phosphor on one side of said base, a transparent conducting film on the other side of said base and a layer of photo-conductive material having a secondary-electron emissive characteristic on said conducting film; a first electron gun mounted within said envelope in a position to bombard said light-emitting phosphor and a second electron gun mounted within said envelope in a position to bombard said photo-conductive material.

3. An electrical storage device comprising an evacuated envelope containing a storage electrode, said electrode having a layer of light-transparent electrically conductive material, a photo-conductive layer on one surface of said material, and a layer of electron-sensitive light emissive phosphor closely spaced to and insulated from the surface of said light transparent electrically conductive material opposite said photo-conductive layer, cathode ray means for establishing a potential difference between said electrically conductive layer and a surface of said photo-conductive layer, cathode ray means for causing said phosphor to emit light and hence to render conductive said photo-conductive layer, and an electrical lead connected with said electrically conductive layer for deriving a signal output, therefrom.

4. The invention according to claim 3 wherein said phosphor and said photo-conductive layer have similar spectral characteristics.

5. A composite device comprising in combination a conducting layer, luminescent means having said conducting layer mounted on the side thereof presented to exciting radiation, a light transparent continuous conducting layer, said light transparent layer being mounted on the opposite side of said luminescent means and being connected to a source of electrical potential, and a photo-conductive layer, all the aforesaid parts forming together a multi-layer screen.

References Cited in the file of this patent

UNITED STATES PATENTS

2,169,840	Lewis	Aug. 15, 1939
2,190,200	Victoreen	Feb. 13, 1940
2,198,479	Langmuir	Apr. 23, 1940
2,258,294	Lubszynski et al.	Oct. 7, 1941
2,293,899	Hanson	Aug. 25, 1942
2,516,314	Goldsmith	July 25, 1950
2,525,768	Bruns	Oct. 17, 1950
2,527,652	Pierce	Oct. 31, 1950
2,540,632	Rose	Feb. 6, 1951
2,544,753	Graham	Mar. 13, 1951
2,549,072	Epstein	Apr. 17, 1951
2,555,091	Lubszynski	May 29, 1951
2,603,757	Sheldon	July 15, 1952