April 11, 1961 F. H. HARRIS 2,979,633

STORAGE ELECTRODE

Original Filed May 1, 1957

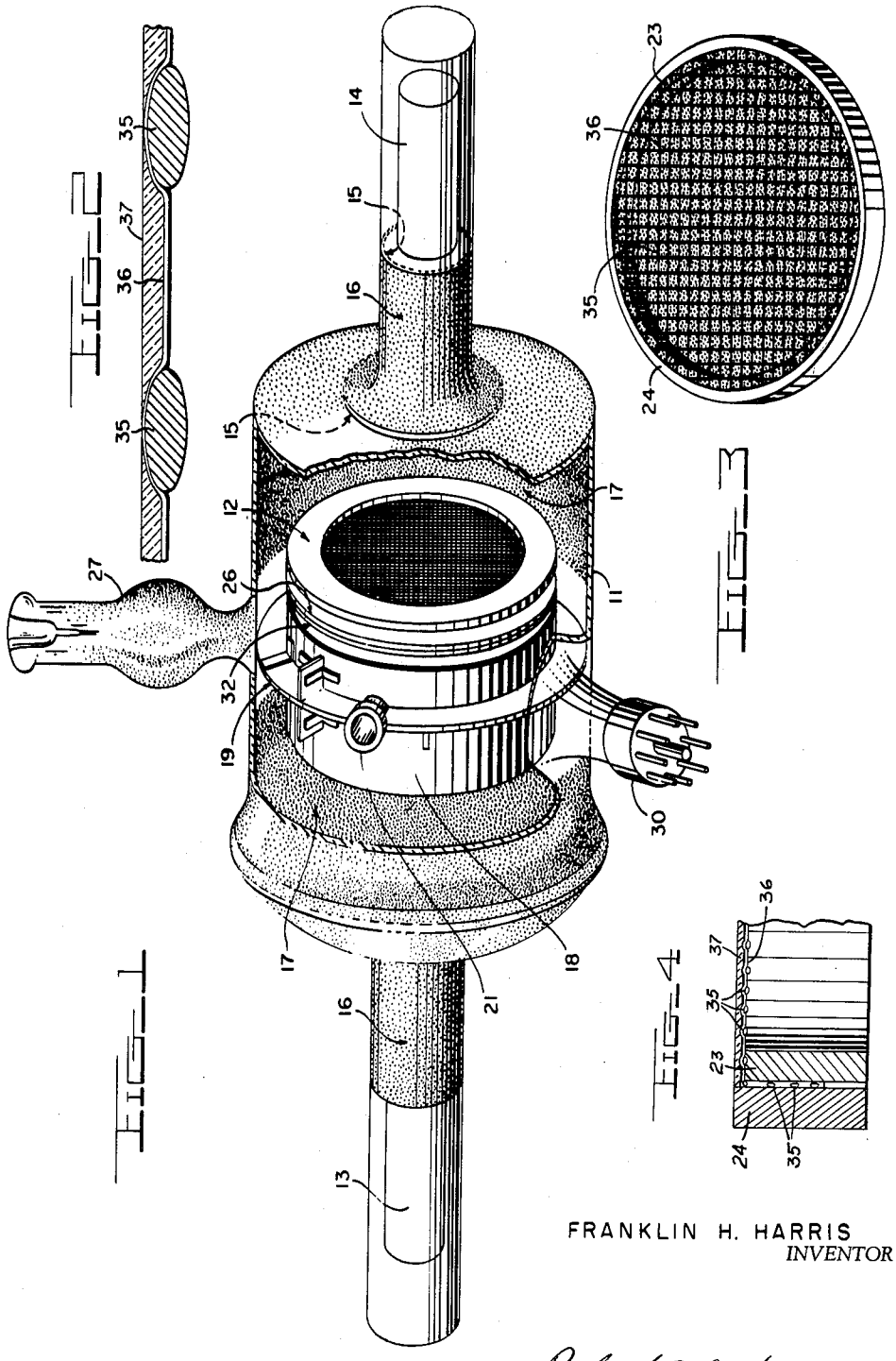


FIG. 1

FIG. 2

FIG. 3

FIG. 4

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United States Patent Office 2,979,633 Patented Apr. 11, 1961

2,979,633

STORAGE ELECTRODE

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Original application May 26, 1958, Ser. No. 737,986 now Patent No. 2,926,419, dated Mar. 1, 1960. Divided and application May 1, 1957, Ser. No. 656,471, now Patent No. 2,957,140, dated Oct. 18, 1960. Again divided and this application Sept. 30, 1959, Ser. No. 843,601

3 Claims. (Cl. 313—89)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This application is a division of application Serial No. 737,986 filed May 26, 1958, now Patent No. 2,926,419, which in turn is a division of application Serial No. 656,471, filed May 1, 1957, now Patent Number 2,957,-140 issued on Oct. 18, 1960, and relates to a cathode ray signal storage element or electrode.

Cathode ray tubes are well known in the prior art which will perform the sequential functions of an information device, namely recording, storage, reproduction and erasure of an information signal. These electron discharge tubes operate upon the principle of translating received information into charges and coincident potentials upon the surface of an insulating material and subsequently recovering this information by exploring the surface with a focused electron beam. As a result of the extremely high impedance offered by an insulator to the flow of current to and from a charged area, in the absence of a reproduction operation the charges and coincident potentials initially impressed upon the dielectric will persist without substantial deterioration over a period of time during which the information which they represent may be made available. When elicitation of the information stored is accomplished, however, by scansion of the insulating surface with an electron reading beam, the information being recovered either as a secondary emission current from the dielectric or as capacitively induced current due to a shift in potential of the initially impressed potentials, in the prior art the information bearing charges and potentials are progressively destroyed with successive repetitions of the reading operation. Thus, in most of the prior art devices information reproduction can only be effected by destructive reading.

In my Patent #2,839,679 there is disclosed a half-tone memory tube comprising three electron guns, namely a writing, a reading and a holding gun positioned in a triangular mount, and a storage surface or target capable of storing a signal for long periods of time. The storage target has a face consisting of an electrically conducting member and an indefinitely large number of separated dielectric masses dispersed throughout the surface of the conducting member in sufficient concentration so that a considerable number of these dielectric masses appear within an area approximating in dimension the spot of a focused electron beam.

The present invention is an improvement over my copending application and provides a two-sided mosaic consisting of a thin film of dielectric formed on an electroformed nickel screen. The new type of mosaic permits greater writing speeds and also provides a storage

surface on which the information is written on one side of the screen and the information is read from the opposite side. This requires a rearrangement of the electron guns such that the read and write guns are directly opposite each other and on opposite sides of the storage surface. The present invention is more specifically related to the storage surface.

The present invention also provides an improvement over the prior art tubes which have read and write guns on opposite sides of the storage screen. In the prior art devices a collector is associated with the screen in the form of a coating on the tube surface or a charged screen adjacent to the storage screen surface. The new mosaic tube of the present invention does away with the usual collector through the use of an improved storage screen which serves to carry out proper storage and also acts as the collector.

It is therefore an object of the present invention to provide an improved signal-storage device capable of half-tone storage and reproduction.

Yet another object is to provide an improved two-sided mosaic which is simply and cheaply manufactured and yet provides good control without any deterioration of the original stored pattern.

A still further object is to provide a new and inexpensive two-sided mosaic.

Other and more specific objects of this invention will become apparent upon a more careful consideration of the following detailed description when taken together with the accompanying drawings, in which:

Fig. 1 illustrates a cathode ray storage tube including the mosaic made according to the method of the present invention and including a write gun on one end and a gun on the opposite end for both holding and reading;

Fig. 2 is a greatly enlarged cross section of the storage surface which illustrates the relationship between the metal screen and the dielectric;

Fig. 3 is an enlarged view of the mosaic screen structure; and

Fig. 4 is a cut-away detailed view of the storage element.

In accordance to the present invention a cathode ray storage tube provided with a mosaic made in accordance to the structure of this invention is capable of capturing a single frame of a television picture which has good tone quality. The storage tube can be used for scan conversion, signal integration, for capturing single transients, and for temporary storage of different patterns such as maps for radar display purposes.

The storage tube device is intended for storing electrical charges and comprises a storage surface including a conductive fine metal screen grid-like structure having a plurality of interstices or openings in which a dielectric material is attached to the grid-like structure and which bridges the interstices. An electrode system is provided for projecting a recording or write cathode-ray beam onto the storage surface during writing intervals and for projecting a holding and reproducing or reading cathode-ray beam on the opposite side of the storage surface during reading. In writing, the write beam produces electric charges on the write side of the dielectric. The charges are stored as potential energy in an electrostatic field which exists partly within the dielectric, and partly in the space between the dielectric and the metal screen. The mechanisms of holding and reading utilize only the electrostatic field in the space near the screen and the field within the dielectric is of no value and therefore should be minimized. For this reason, the dielectric is formed as thin as possible.

Referring now to the drawings wherein like reference characters represent like parts throughout, the device shown by illustration in Fig. 1 comprises an evacuated

glass envelope 11 which encloses a storage electrode or mosaic 12 and two conventional cathode-ray guns 13 and 14. The cathode ray guns are positioned respectively in opposite ends of the tube on opposite sides of the storage electrode and are magnetically focused and deflected in the conventional manner as used in television picture tubes. Conductive coatings 15 and 16 of silver paint are respectively provided on the inside and the outside of each end of the envelope to shield the storage mosaic from the electrostatic fields of the deflection coil and yet does not interfere with the magnetic fields. The inner coatings 15 merge with transparent conductive coatings 17, such as a metallic oxide, which serves as the second anodes and are transparent to facilitate inspection of the inside of the tube if desired. A cylinder 18 positioned within the envelope on the read-beam side of the storage mosaic serves to collimate the read-beam electrons in order to obtain equal values of forward electron velocity over the surface of the mosaic. The collimating cylinder is provided with a ridge 19 about the outer surface thereof for the purpose of securing the cylinder within the envelope; for purpose of illustration, three glass holders 21 are provided for securing the collimating cylinder in position. The inner surface of the collimating cylinder has three equally spaced tabs or lugs attached thereto along one end about the inner circumference to provide means for securing the mosaic surface in position with respect to the electron guns and the collimating cylinder. The structure for securing the storage element within the storage tube is more fully described and shown in the parent Application No. 656,471 filed May 1, 1957, now Patent Number 2,957,140 issued on Oct. 18, 1960. The tube is provided with a getter 27 to keep the residual gas pressure low during operation.

The mosaic comprises a thin dielectric film 36 having a thickness of from about .02 micron to about 1.3 microns which bridge the interstices or openings of a fine mesh nickel screen 35 having a thickness of about 0.00005 to about 0.0006 inch and from 300 to 1000 mesh per inch and formed according to the following method. The outer edge of the screen is placed over a nickel-plated steel ring or hoop 23, stretched taut and then held in position by placing ring 23 into a second like ring 24 of larger diameter. In order to position ring 23 with the fine mesh over it into ring 24, ring 23 is cooled to shrink the ring and ring 24 is heated to expand it. The screen covered ring is then slid into ring 24 and the rings are allowed to return to their normal temperatures whereby the screen and ring is held tightly in ring 24. The assembly is then cleaned by washing it in water with a detergent and then in acetone to remove any foreign solids, salts or oils. Then the assembly is placed on a level surface and water is applied to the screen surface for wetting purposes.

The dielectric film is formed from a preparation of bentonite clay hydrosol made from bentonite clay (montmorillonite) which is a natural mineral classed as an aluminosilicate $Al_2(Si_4O_{10}).\times H_2O$. A refined form of bentonite clay hydrosol containing 2.3% solids by weight is diluted with distilled water to form a fluid which contains a much lower concentration of solids about 2.8×10^{-4} parts by weight. In percentage concentrations of 1% or more, the hydrosol has the property of being a thixotropic gel (the property of becoming fluid when agitated and returning to a gel when left undisturbed). The dilute 2.8×10^{-4} parts solid hydrosol appears to have the properties of viscosity and surface tension identical to those of distilled water and can be applied to the screen in liquid form.

The screen is prepared for coating as described above and the surface thereof wet with a pool of distilled water one to two millimeters deep for approximately twenty minutes. The small mesh of the screen and the surface tension of the water serves to prevent the water from going through the screen; however, if the screen is extremely clean the water will run through. In order to obviate this, the screen is purposely contaminated with any suitable solution, for example by immersing the screen momentarily in a solution of amyl acetate and 10^{-3} parts by volume of collodion. This is allowed to dry and then the distilled water is placed on the surface as described above.

After the distilled water has been on the screen surface approximately 20 minutes, most of the water is drained off with the aid of an aspirator or any other convenient means. The removed distilled water is immediately replaced with the 2.8×10^{-4} parts solid bentonite clay hydrosol which has been vigorously stirred to insure a thorough dispersal of the solids. Approximately four milliliters of the hydrosol fluid will easily spread over an area of about 40 square centimeters (a 2⅞ inch diameter screen) to form a pool one millimeter deep. The water evaporates from the solution and the surface of the screen, to leave a uniform film of bentonite clay which weighs approximately 1.1 milligrams and having a thickness of 0.1 micron (4×10^{-6} inches). The average thickness of the film is determined by the formula

$$d=\frac{(w)(10^4)}{(S.G.)A}$$

where d is the thickness in microns, w is the weight in grams of the formed film, S.G. the specific gravity, and A is the area ($cm.^2$) of the covered screen. The above values for forming the dielectric film are typical values for a preferred dielectric film and other concentration of solids may be used to form films having different thickness. Hydrosols containing 8.25×10^{-5} to 2.0×10^{-3} solids by weight will form suitable dielectric films having a thickness of from about 0.02 micron to about 1.3 microns, the thickness of the dielectric film is limited by the thickness and strength of the screen surface. If the hydrosol placed on the screen is too heavy the screen will tear away and films cannot be formed; therefore, the thickness of the film is limited to the strength of the screen.

It is highly important that dust particles do not settle on the screen during forming and that the film have uniform thickness. For this purpose the screen is placed on a stationary level stand or flat surface and a glass cover is placed over the screen as soon as the hydrosol has been placed on it. Since the screen is covered, drying proceeds slowly wherein the water is formed to evaporate primarily from the underside through the openings in the screne. Since the hydrosol has approximately the properties of viscosity and surface tension of distilled water, the fluid is pulled by gravity into the interstices of the screen wherein the fluid clings to the screen surface due to surface tension, this forms a uniform film within the interstices which is thicker than the film over the screen surface. When the water has evaporated and the film formed onto the screen, the screen is removed from the glass cover. The screen in this state can be used as a storage surface; however, the film does not demonstrate as low an electrical conductivity as mica and has slight electrical leakage, therefore it is necessary to further treat the film to obtain the desired dielectric qualities.

The bentonite clay film can be converted to a low-conductivity material similar to mica by either of the following two methods. In one method, the storage screen is removed from under the glass cover and placed in a container such as a stainless steel vented container and heated at approximately 1000 degrees for 20 minutes in hydrogen. The stainless steel vented container serves to shield the screen from the heating flame of the hydrogen furnace and also provides thermal lag which prevents rupture of the storage surface when the container is removed from the furnace. The screen being thin would shrink more rapidly than the mounting rings and

therefore would rupture if allowed to cool too rapidly. The storage surface is removed from the hydrogen atmosphere while it is hot (approximately 400 degrees centigrade) and cooled within the container in air. It has been determined that removal from the hydrogen at a temperature below 400 degrees centigrade makes the bentonite film slightly conductive and when removed at temperatures greater than 400 degrees centigrade, a slight oxidation of the nickel screen occurs. Oxidation is not significantly harmful for operation in the tube of the present invention.

In another method of converting the bentonite clay film to a low-conductivity material, the film is treated with lead. Bentonite clay dispersed in water is necessarily sodium bentonite, therefore the dried film on the screen is sodium bentonite clay. The assembly of the screen with the dried film thereon is immersed in a concentrated lead-nitrate solution. A base exchange reaction occurs in which the sodium of the film is replaced by lead. After about a five-minute immersion in the lead-nitrate solution, the assembly is removed from the solution, rinsed with distilled water and then dried. The films are nonconductive and have the properties of mica. Films as thin as 20 millimicrons have been formed by this method, wherein such thin films formed by the first method would disintegrate due to the high heat intensity.

In either method described above, the conductivity of the films is comparable to that of mica, and this, combined with their thinness, results in negligible conductance along their plane. Even though the films are very thin, they can withstand the high bake temperature (400° C.) required to outgas the tube. In addition sodium-bentonite films have excellent mechanical adherence to the nickel screens in order to form the thin films in the interstices of the screen and in which that portion of the film covering the conducting portions of the screen are thinner than that within the interstices.

A mosaic formed according to the above method combines a metal screen and a very thin insulator in which the insulator is formed in the interstices such that the cells of the insulator are electrically guarded one from the other by the conductor screen. The read beam bombards both the conductor and insulator to fulfill read and hold functions, and the write beam can charge the insulator and control the field on the read side. The latter is attained by forming the insulator very thin, so that large voltages cannot exist between the write and read surfaces, and the insulator has high resistivity so that the written charges will not leak off.

In some other type cathode ray tubes it may be desirable to make a conductive screen with a thicker insulator surface in which it is essential that one face surface of the screen be in contact with the insulator material. For such tubes, the storage electrode made according to the

above method can be used wherein the dielectric film side of the storage electrode is used as a substrate and an insulating material 37 added thereto by any well known method such as the evaporation technique, or the water dispersed colloid suspension method. For example, quartz, silicon dioxide or aluminum oxide can be added to the bentonite clay film to increase the thickness of the insulating surface. The application of the additional insulating surface by the colloid suspension method is preferred since the liquid would flow into the interstices, fill the interstices and then provide a smooth outer surface. In the evaporation method the insulation would build up over the screen surface as well as in the interstices. The method used depends on the outer surface desired.

For a more complete and detailed discussion of the electrical operation of the mosaic due to the incident beam from the writing and reading guns and operation of the storage tube is set forth in my Patent No. 2,839,679 and in the parent application Serial No. 656,471, filed May 1, 1957, now Patent No. 2,957,140, issued on October 18, 1960.

The present invention is concerned with the use of this dielectric film for the mosaic of a storage tube; however, it would be obvious to anyone skilled in the art to use thin dielectric films for other uses. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An electron beam target for a cathode ray device comprising a conductive grid-like structure having a plurality of interstices, a dielectric film distributed on a single surface of said grid-like structure, said film extending into and across said interstices in a plane midway between the outer surfaces of said grid-like structure, said film extending into and across said interstices having a thickness greater than the thickness of said film over said grid-like structure and a second dielectric film distributed over the surface of said first dielectric film.

2. An electron beam target for a cathode ray device according to claim 1 in which said second dielectric film distributed over the surface of said first dielectric film forms a uniform back surface.

3. An electron beam target for a cathode ray device according to claim 1 in which said second dielectric film distributed over the surface of said first dielectric film approaches a smooth uniform back surface.

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