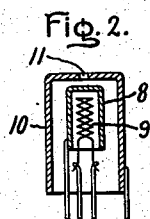
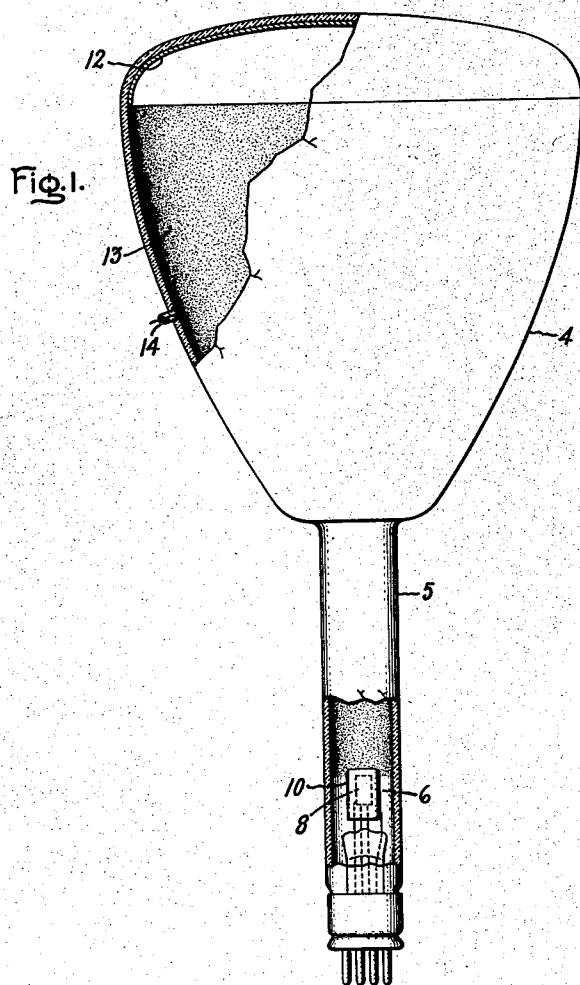


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LE ROY E. RECORD
ELECTRICAL DISCHARGE DEVICE
Filed Feb. 27, 1940

2,264,858



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UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE DEVICE

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Application February 27, 1940, Serial No. 321,030

5 Claims. (Cl. 250—27.5)

The present invention deals with improved conductors, or film electrodes, for electric discharge devices, and in particular highly evacuated devices, such, for example, as cathode ray tubes. It is the object of my invention to provide thin, firmly adherent coatings for such devices which readily can be rendered free from gas.

In cathode ray tubes, such as used in television apparatus, a fluorescent coating is applied upon the inner surface of an approximately plane surface of the tube or bulb and a conductive coating of graphite or the like is applied upon an interior surface of the envelope adjacent the fluorescent coating. This conductive coating functions as an electrode for controlling the electron beam whereby the fluorescent coating is excited to fluorescence.

In order to apply non-adhesive materials, such as finely divided carbon or metal, on a base of glass, or similar smooth surfaces, such as the envelope wall, various adhesive bonding agents have been employed whereby the non-adhesive, conductive material becomes bonded to the base. The characteristics of such bonding agents have presented a troublesome problem in the manufacture of electric devices. Organic bonding materials especially are subject to gas evolution, even when subjected prior to sealing the device to thermal treatment intended to decompose or burn out the residue of the bonding agent.

Apparently gas evolution is the remote cause of the dark areas, termed "ion spots," which frequently appear during operation on the fluorescent screens of television tubes. The ionization of gas in television tubes results in cathode bombardment by positive ions and produces disintegration of cathode material. The products of disintegration are believed to be directly responsible for the darkened screen areas or ion spots.

In accordance with my invention, conductive films are produced by coating the envelope interior with a suspension in a liquid of a finely divided conductive solid, such as graphite, which is associated with an inert, stable, inorganic material such as bentonite.

The accompanying drawing illustrates in Fig. 1 a cathode ray tube, such as used in television apparatus, which is provided with a conducting film comprising bentonite; Fig. 2 being a detail view of cathode construction.

Bentonite is a natural hydrosilicate of alumina having the distinctive property of forming a homogeneous and viscous gel in the presence of a relatively large amount of water. It is used

industrially as a "filler," also as a filtration medium. Chemically, bentonite may be represented by the formula $Al_2O_3 \cdot 4SiO_2 \cdot xH_2O$. The alumina may be replaced by magnesia as in white bentonite. It is no more hygroscopic than more common argillaceous material, but bentonite does have a great physical avidity for liquid water. While this feature gives to bentonite its advantage in forming colloidal suspensions, the water is readily eliminated, leaving a residue which does not give up gas during the normal operation of an exhausted device.

Colloidal bentonite suitable for the purposes of the present invention may be prepared by agitating about $2\frac{1}{2}$ per cent of commercial white bentonite in $97\frac{1}{2}$ per cent distilled water, and allowing the resulting suspension to stand for a protracted period, say for about a week, in order to permit gravity separation of coarser material which may be discarded. The supernatant liquid product, which may be removed by syphoning, or any other suitable way, if desired may be further classified as to the size of particles by the action of a high speed centrifuge. Preferably, a suspension in water or other suitable liquid of bentonite having a particle size of about one-tenth micron and smaller is used.

The suspension is diluted to a desired concentration conveniently with distilled water. Aqueous suspensions of bentonite having a low concentration, ordinarily less than two per cent solids, have been found desirable for carrying out my invention. The percentage of solids may be determined by weighing a few cubic centimeters of the aqueous bentonite suspension, drying at $110^\circ C.$ to constant weight, and determining the relation of the residue to the original weight of the suspension.

My invention may be embodied in conducting coatings for the interior of cathode ray tubes and as illustrated in the drawing. The device shown in this figure consists of a generally pear-shaped glass bulb 4 joined to a narrow tubular neck portion 5, in which is mounted a source of electrons 6. As better shown in Fig. 3, this source includes a thermionic oxide-coated cathode 8 which is provided with an internal heater 9 as diagrammatically indicated. Outside the cathode is a primary anode or grid containing an orifice 11 through which the electrons or "cathode rays" emerge.

At the opposite extremity on the rounded end of the tube which provides an approximately plane surface is provided a coating 12 of fluorescent material. It is shown in the drawing of

somewhat enlarged thickness. Intermediate the fluorescent coating 12 and the electron source 8 there is provided on the flared portion of the tube and on an adjoining section of the neck 5 a thin coating 13 of conductive material, such, for example, as graphite, which is bonded with a gas-free residue from the bentonite gel. The coating 13 makes electrical contact with a sealed-in conductor 14 and functions as the so-called final anode of the cathode ray tube.

A composition suitable for producing the conductive coating 13 may be made up of the following ingredients:

Bentonite suspension containing about	
1.75% bentonite solids.....cc-----	1000
Graphite or other gas-free carbonaceous material -----grams-----	150

This mixture is ball-milled to render it thoroughly homogeneous. In place of carbon, finely-divided metal or other suitable conductive material may be employed. The mixture may be applied upon the glass surface, for example, by causing the liquid suspension to enter the narrow neck of the tube before the electrodes have been mounted. The liquid is caused to rise to the required height adjacent the fluorescent screen as indicated, and then is withdrawn to leave a coating. The coating also may be applied in any other convenient way, as by spraying or painting the same upon the glass surface. Upon the drying of the coating there results a uniform, adherent film 13 consisting of conductive material bonded with solid, gas-free bentonite. It is electrically conducting and stable under the conditions of operation of the device. After the usual bake-out and exhaust of the tube, the coating or film thus made evolves little or no gas.

The proportions here given are illustrative only. In general, I may use a composition made up of about 1000 cc. of water, having suspended therein about 0.3 to 2.5 per cent by weight of bentonite that is, from 3 to 25 grams of bentonite, and about 100 to 500 grams of graphite.

The fluorescent screen 12 may be applied with approved conventional bonding agents, but in order to provide the most favorable gas-free conditions, the utilization of bentonite as a bonding agent for the fluorescent material is advantageous. A copending application, Serial No. 311,545, filed by Vincent J. Schaefer on December 29, 1939, covers related features of the present invention, in the field of fluorescent film devices.

In accordance with one method of forming a fluorescent screen, an aqueous suspension of colloidal bentonite containing about 0.9 per cent solids is flowed evenly over the flattened surface of the cathode ray tube which is to be coated with fluorescent material. The excess material is removed by suction. The resulting bentonite film is partially dried until a sticky condition results. A suitable, finely divided fluorescent material, such as zinc sulphide or zinc silicate, is applied to the sticky film by dusting the fluorescent material over the sticky film to which it adheres. The coated film then is dried. If desired, an additional coat of bentonite may be applied over the surface of the fluorescent material to more thoroughly bond it in place.

The structural features of the device of Fig. 1 have been only diagrammatically indicated as they do not form part of the present invention. They are more fully described in Zworykin Patent 2,109,245, patented February 22, 1938.

Upon completion of the device it is evacuated by conventional methods to a pressure so low that the gas ionization effects are inappreciable during of the suspension.

In order to increase the viscosity of the bentonite suspension without unduly increasing the concentration of bentonite, suitable addition materials may be introduced, such for example as chlorides of sodium or potassium, or magnesium oxide and sodium hydroxide, which cause gelation. The addition of such agents is accompanied with some disadvantages as thereby the amount of solids present is somewhat increased. On the other hand, the viscosity of the suspension may be raised by the addition of ethyl alcohol, which does not increase the solids present. The alcohol evaporates readily, thus accelerating the drying of the suspension.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A discharge device comprising an evacuated envelope, electrodes therein for an electric discharge therethrough, and a cooperating electrode applied on an inner surface of said envelope comprising as essential ingredients an intimate mixture of finely divided conductive material and a bonding agent consisting substantially of about 2.5 per cent of bentonite unassociated with other bonding material.

2. A vacuum device comprising an envelope of vitreous material and an adherent conductive film thereon comprising as substantial and essential ingredients an intimate mixture of graphite and about 2.5 per cent bentonite, said film being unassociated with other binding agent.

3. An electrical discharge device comprising an evacuated glass tube, electrodes therein for producing an electronic discharge therein, and a control electrode therein comprising a baked, gas-free, stable coating on a portion of said tube, said coating comprising the baked residue of a suspension in a liquid of a mixture of particles of conductive material and particles of natural bentonite having a maximum size of about one-tenth micron.

4. A cathode ray device comprising an evacuated elongated glass bulb, a source of electrons therein, a fluorescent screen located in spaced relation to said source, and intermediate cooperating electrodes, one of which consists of a graphite film coated on an interior surface of said bulb, said film containing by weight about 3-25 parts of bentonite to 100-500 parts of graphite.

5. An electrical discharge device comprising an evacuated envelope, electrodes therein for supporting an electric discharge, and a cooperating electrode comprising a coating on an interior surface of said envelope, said coating consisting solely of a mixture of finely divided conductive material as a major constituent by weight and bentonite as a minor constituent by weight.

LE ROY E. RECORD.

CERTIFICATE OF CORRECTION.

3

Patent No. 2,264,858.

December 2, 1941.

LE ROY E. RECORD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 2, for "bentoniate" read --bentonite--; page 2, first column, line 67, for "be be" read --be--; and second column, line 9, for "of the suspension" read --its operation--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of January, A. D. 1942.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.