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GAS-FILLED COLD-CATHODE INDICATOR DISPLAY TUBE

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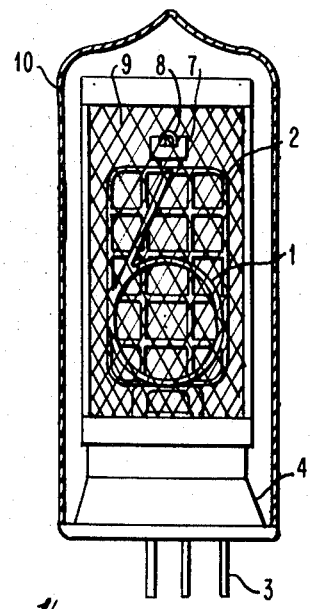

Fig. 1

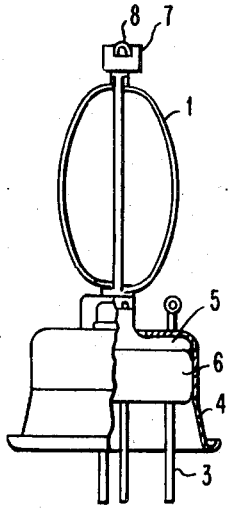

Fig. 2

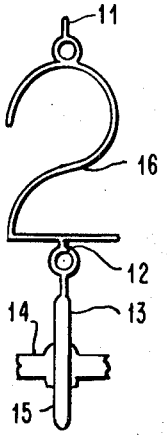

Fig. 3

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GAS-FILLED COLD-CATHODE INDICATOR DISPLAY TUBE

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Int. Cl. H01j 7/40, 17/32, 65/48
U.S. Cl. 313—54 5 Claims

ABSTRACT OF THE DISCLOSURE

A miniature gas-filled cold-cathode indicator display tube wherein an electrically insulating oxide of a radioactive metal isotope having a long half-life (having a long period of half decay), such as thorium oxide, uranium oxide or vanadium oxide is placed within the envelope of the tube to prevent the ionization voltage from increasing when the tube is operated under adverse conditions.

FIELD OF THE INVENTION

This invention relates to a miniature gas-filled cold-cathode indicator display tube. Generally, in such indicator display tubes, the tube envelope is filled with an inert gas consisting of neon mixed with a small amount of argon to make the ionization easy.

Since the equipment (i.e., computers and the like) using such indicator display tubes tends to become smaller and smaller year by year, small-sized indicator display tubes are required. This necessitates making the volume and the distance between electrodes of tubes so small that the ionization of the gas in the envelope of the tube and the self-increase of the gas ions are difficult to control and thus, the ionization voltage increases.

Further, in equipment utilizing gas filled indicator tubes, the tubes are mounted where they are shielded from the light. If the ordinary indicator display tubes are used under these conditions, the ionization voltage will increase and possibly cause unreliable indicator tube operation.

DESCRIPTION OF THE PRIOR ART

In the prior art, preventing an increase in the ionization voltage of discharge tubes, such as switching tubes, was achieved by utilizing the radiation of a radioactive isotope, for example, by coating electrode parts with a cobalt chloride solution including ^{60}Co. However, it is impossible to use this method for indicator display tubes, since high purity is required for the electrode surfaces (i.e., numeric cathode elements) of the tubes. If a radioactive isotope, such as cobalt chloride, is contained in the tube envelope, impure components included in it are emitted or the coating material becomes conductive and an improper discharge results.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a miniature indicator display tube wherein the ionization voltage does not substantially increase even when used under the adverse conditions described above.

Another object of this invention is to provide such a tube whose manufacture requires no particular complicated processes and which is equal in cost to the conventional tubes.

It is yet another object of this invention that in such tubes only the area of the cathode element which is to be displayed glows, and that the areas not to be indicated do not glow.

According to this invention, an indicator display tube contains an electrically insulating oxide of a radioactive metal isotope within the envelope thereof.

Further, according to this invention, the radioactive material can be contained within the envelope of an indicator display tube by coating the non-glowing areas of the tube with the electrically insulating oxide of radioactive metal isotope (called hereinafter radioactive material) described above by means of a binding material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front outline view of a miniature indicator display tube according to the invention;

FIG. 2 is a frontal view of a portion of the tube shown in FIG. 1; and

FIG. 3 is an enlarged outline view of the display area and the stem sealing part of a conventional indicator display tube.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, a miniature indicator display tube according to this invention includes an envelope **10** which has a high light transmittancy on at least the area on the display side thereof. Mounted within the envelope **10** is an external mesh anode **9** of high transmittancy which does not impair the visibility of the display of the display tube. Further provided is a plurality of display cathode elements (in the form of alpha numeric characters or the like) which are fabricated as a single body having an outside lead **3** which is sealed to the base of the tube. The tube also contains an internal anode **2** fabricated as a single body and also having an outside lead **3** which is sealed to the base of the tube. The leads **3** extend through and are sealed to a stem which comprises a stem shell **4**, and under ceramic support **5** and sealing means **6**. Preferably, sealing means **6** is a sealing glass or the like. An upper insulating support **7** is also provided within the tube to cooperate with an electrode mount **8** which is secured to the cathode elements. In a preferred embodiment, the radioactive material is applied to the electrode mount element **8** by means of sintering or the like.

The basic structure of the tube shown in FIGS. 1 and 2 is substantially similar to the tube structure described in co-pending U.S. patent application Ser. No. 527,280, now Pat. No. 3,437,861. Therefore a more detailed discussion of the construction of the tube of FIGS. 1 and 2 is not included herein.

In the indicator display tubes according to this invention, the radioactive material may be included in the envelope by means of a coating method or a forming method. If the coating method is used, it may be implemented either by a coating and drying technique or by a coating and sintering technique.

The coating and drying method of including the radioactive material within the tube envelope will now be

described. A bonding agent such as sodium silicate is added to the radioactive material. The combination is then applied, fixed and dried on a non-glowing portion of the cathode assembly. In a preferred embodiment, the radioactive material is applied in this manner to the electrode mount **8**.

In the coating and sintering method, powdery glass is added to the radioactive material. Then, pyloxylin or methacrylic resin is added to the mixture. This resulting mixture is melted with butyl acetate or amyl acetate and the desired parts of the tube, such as electrode **8**, is coated. The coated portions are then put into the sintering oven during the assembly process for the tube and are sintered at the temperature of approximately 900° C. to 1300° C. It is pointed out that at the same time, the sealing glass **6** is melted and provides a seal at the base of the tube. The temperature for sintering depends upon the quality of the sealing glass **6** which melts and hermetically seals with the lead-in wires **3** and the under portions of the stem shell **4**. This operation also fixed the leads **3** permanently in place. During this operation, the radioactive material is sintered onto the electrode mount **8** and additionally provides a bond between the electrode mount **8** and the upper ceramic support **7**.

It has been found in practice that satisfactory results are achieved with either the coating and drying method or the coating and sintering method. No significant differences between these processes have been discovered.

The aforementioned forming method consists of forming the upper and/or lower ceramic supports, **7** and **5**, respectively, of radioactive material. In this method, magnesiumsilicate ($MgOSiO_2$) is added to the radioactive material to maintain the characteristics of the support member similar to the characteristics of the ceramic support and paraffin is added as a bonding agent. This mixture is then pressed into the desired form and sintered at about 1300° C. In this manner, radioactive supports **5** and/or **7** are produced which thereby provide sufficient radioactive material within the envelope of the tube to prevent the ionization voltage from increasing.

The necessary amount of radioactivity in the indicator display tube, which can be obtained by any of the different methods described above, depends upon the characteristics of the tube and its use. But, it has been found that the presence of 0.01 μc. radioactivity generally provides the desired results. The amount of radioactivity required is not fixed, but can be selected according to the tube size and its use. The volume of radioactivity can be adjusted by adding an adequate volume of powdery glass or alumina powder to the radioactive material.

In small-sized indicator display tubes having an ionization voltage of 140 v. under the normal conditions, the ionization voltage increases up to 200 v. in the darkness. When only 10 mg. of thorium oxide as the radioactive material is contained within the envelope of the tube in the manner described above, the volume of radioactivity is only 0.001 μc. However, the presence of the thorium oxide lowers the ionization voltage to under 150 v., even in the darkness. In comparison, the advantage of this invention becomes clear in connection with the miniaturization of the tube, wherein the distance between electrodes is small.

Referring now to FIG. 3, there is shown a typical electrode in a display tube of conventional design. This typical electrode includes a symbol **16** which is made of a material designed to glow when the electrode is energized. Secured to the upper portion of symbol **16** is a mounting member **11** and secured to the lower portion of the symbol is a mounting member **12** which in turn is secured to a lead-in wire **13**. The lead-in wire **13** is sealed to the base of the tube by means of a sealing means **14** which preferably is glass. The subject invention may be applied to display tubes using conventional electrodes by means of coating the mounting members **11** and **12** and the portion of the lead-in wire **13** that is within the tube with the radioactive material according to this invention. By using this technique, only the portions of the electrode **16** which is intended to be displayed will glow when the electrode is energized.

In the previously known indicator display tubes, the leads for the electrode **16** which were made of the same material as the display area **16**, glowed together. In order to eliminate this phenomenon, in the prior art the portions of the cathode which were not intended to glow were electrically shielded by means of an insulating material such as mica which does not discharge gas and which does not evaporate. Alternatively, the portions of the cathode which were not intended to glow were coated with aluminum oxide powder or chrome oxide.

However, according to this invention as described above, the portions of the cathode which are not intended to glow are coated with radioactive material which is also a good insulator. Alternatively, these portions of the electrode may be formed with the radioactive material as described above. This not only prevents the coated portions of the electrode from glowing, but also maintains the ionization voltabe of the indicator display tube at a relatively low level. Thus, the radioactive coating according to this invention serves a dual function.

Generally, in manufacturing indicator display tubes, the secondary emissivity on the electrode surface can fall due to oxidation contamination occurring when the glass is processed or due to unskillful treatment, thereby causing an increase in the ionization voltage. However, this invention also alleviates this difficulty. The reason for this is that the ionization of gas molecules is facilitated by the action of the α, β and γ radiations emitted from the radioactive material which is in the tube. Therefore, the outside conditions and the self-increasing of the filled gas ions do not have as great an effect on tubes produced according to this invention.

Suitable radioactive metal isotopes for use in this invention are materials having a long half-life, such as thorium oxide, uranium oxide or vanadium oxide. Other materials, not specified, may also be used.

It is again pointed out that since the radioactive material used in this invention is an insulator, the portions of the cathode electrodes of FIG. 1, 2 or 3 coated therewith or formed thereof will not glow when the electrode is energized, even if the coated portion is made of the same material as the glowing part of the cathode. Thus, the radioactive material in this invention may serve the dual purpose of lowering the ionization voltage and preventing portions of the cathode from glowing.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the accompanying claims.

What is claimed is:

1. In a gas-filled cold-cathode indicator display tube having an envelope, an anode electrode and a cathode display structure including at least one cathode display electrode, the improvement wherein portions of said cathode display structure which are not to be displayed comprise an electrically insulating oxide of a radioactive metal isotope, said portions being located within said envelope to reduce the ionization voltage.

2. The tube of claim **1** wherein said radioactive metal isotope is selected from the group consisting of thorium oxide, uranium oxide and vanadium oxide.

3. The tube of claim **1** wherein said cathode display structure portions which are not to be displayed have a coating of said electrically insulating radioactive material thereon.

4. The tube of claim **1** wherein the cathode display structure includes a mounting member, at least a portion of said mounting member having a coating of said insulating radioactive material.

5. The tube of claim **1** wherein said cathode structure includes a mounting member and wherein said tube fur-

ther includes a support member to cooperate with said mounting member for securing said cathode structure within said tube, said support member incorporating said radioactive material.

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