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E. A. MASSA ET AL
ELECTRIC DISCHARGE DEVICE

2,178,238

Filed March 17, 1937

FIG. 1.

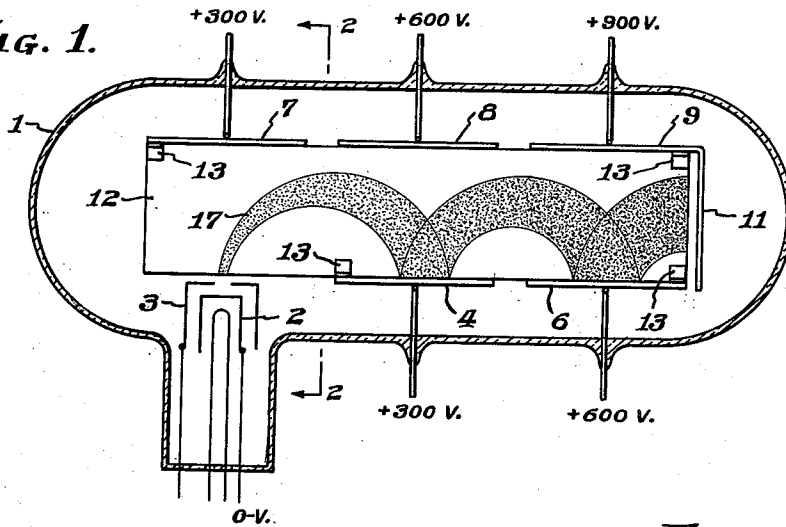


FIG. 2.

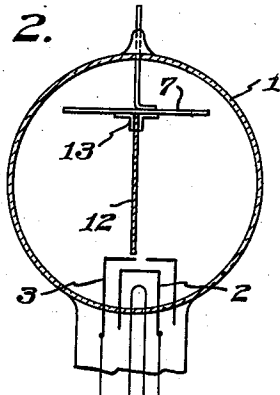


FIG. 3.

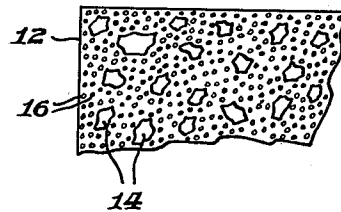
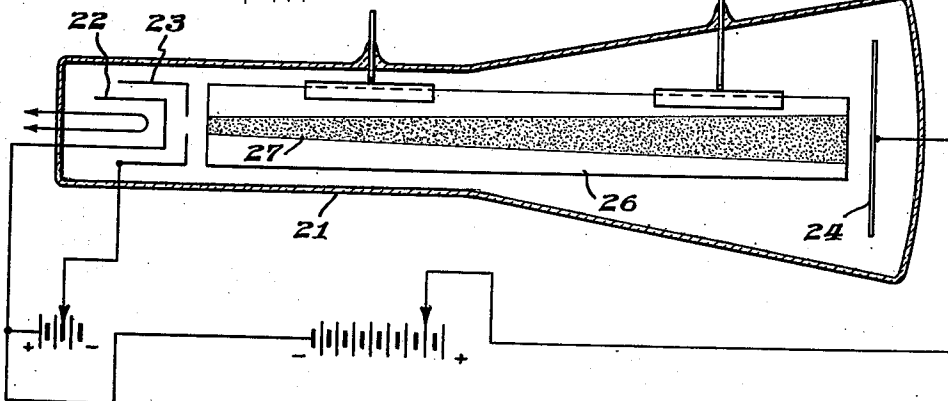


FIG. 4.



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ELECTRIC DISCHARGE DEVICE

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Application March 17, 1937, Serial No. 131,300

2 Claims. (Cl. 250-174)

Our invention relates to electric discharge devices, and particularly to devices for making visible the paths of electrons.

In electron multiplier tubes and in image tubes, for example, such as described and claimed in Malter Patent No. 2,073,599, issued March 9, 1937, and in application Serial No. 56,850, filed December 31, 1935, in the name of George A. Morton, both assigned to the Radio Corporation of America, the electrons travel along rather complicated paths from the electron source to the output electrode or screen. Ordinarily, of course, these paths of the electrons are invisible and are determined by calculating the effects of electric fields upon the electrons.

An object of our invention is to provide a method of and means for making visible the path along which electrons travel.

A further object of our invention is to provide an improved device for demonstrating the operation of electron multipliers, image tubes, cathode ray tubes, and the like.

A still further object of our invention is to provide an improved cathode ray tube indicating device.

In a preferred embodiment of our invention, a demonstrating tube is built which is a model of the type of tube to be studied or demonstrated. The tube model has supported therein a fluorescent screen comprising a sheet of mica, glass, or the like, coated with fluorescent material, this screen being positioned parallel to the direction of travel of the electrons. A luminous trace will appear on the screen as it is struck by a portion of the passing electrons. For the best operation, the insulating sheet, in addition to being coated with fluorescent material, should be specially treated to make it sufficiently secondary electron emissive to prevent it from acquiring a negative potential. Thus, the electrons will not be repelled by the fluorescent screen, but instead a portion of them will be drawn toward it as the screen will be slightly positive in most cases.

The invention will be better understood from the following description, taken in connection with the accompanying drawing, in which

Figure 1 is a side view of an electron multiplier tube embodying our invention,

Figure 2 is a view taken on the line 2-2 of Fig. 1, looking in the direction of the arrows,

Figure 3 is a view of the fluorescent screen employed in the tube shown in Fig. 1 as it looks under a microscope, and

Figure 4 is a side view of a cathode ray tube embodying our invention.

Referring to Figs. 1 and 2, we have shown our invention applied to an electron multiplier tube of the type described in the above mentioned Malter patent. As the multiplier tube itself forms no part of the present invention, it will not be described in detail, but as shown it comprises an evacuated envelope 1 having an indirectly heated cathode 2, a control electrode 3, and a plurality of secondary emissive electrodes 4 and 6. The envelope also has therein a plurality of electrodes 7, 8 and 9, located opposite the electron emitting electrodes 2, 4 and 6, respectively, for the purpose of accelerating the electrons. The electrodes function in cooperation with a transverse magnetic field to direct the electrons through the desired arc, the magnet for producing this field being omitted from the drawing in order to simplify it.

The output electrode of the multiplier tube is indicated at 11, this electrode being supported from and electrically connected to the electrode 9. Voltages of the order indicated may be applied to the several electrodes.

In accordance with our invention, a fluorescent screen 12 is mounted in the tube 1 along its longitudinal axis. The screen 12 may be supported from the electrodes 4, 6, 7 and 9 by means of small brackets 13. As indicated in Fig. 2, the screen 12 may be positioned at one side of the source of primary electrons whereby the electron stream will graze the fluorescent screen surface. If a very thin fluorescent screen is employed, it obviously may be positioned centrally with respect to the cathode 2 and to the control grid aperture.

It has previously been pointed out that the fluorescent screen should be sufficiently secondary electron emissive to keep it either at zero potential or, preferably, at a slight positive potential. In other words, it should be sufficiently secondary electron emissive to make the ratio of secondary electrons to primary electrons at least as great as unity. A preferred screen construction will now be described. A sheet of insulating material, such as mica or glass, first has silver beads formed thereon. The beads may be formed in several well known ways. For example, the mica may be dusted with silver oxide powder and then heated to reduce it to silver, or the mica may have silver sprayed or evaporated thereon, after which the silver film is caused to break up into globules by heating it.

After the silver beads have been formed, the silver bead surface is sprayed with a fluorescent material, such as willemite. This may be done

by mixing dry willemite powder with amyl acetate to form a spray solution or mixture. The amyl acetate evaporates after the mixture has been sprayed on, leaving only the willemite.

5 The silver beaded mica surface should not be completely covered with willemite. Preferably, only enough of the willemite is sprayed on to cover from 20% to 40% of the beaded mica surface. The character of the screen as it appears when magnified about 200 diameters is indicated in
10 Fig. 3, the larger particles 14 being willemite and the smaller particles 16 being the silver globules.

After the fluorescent screen has been prepared, as described above, it is mounted in the tube in
15 which it is to be used, as shown in Fig. 1, for example. The screen is next sensitized by first oxidizing the silver and then admitting an alkali metal, such as caesium, after the tube has pumped to a good vacuum.

20 The oxidizing of the silver may be accomplished by means of a glow discharge, as described in Essig Patent No. 2,020,305, the silver turning blue when it becomes oxidized. The caesium is admitted and the tube baked until the screen
25 appears brown in color.

The above described screen 12 operates at a few volts positive whereby some of the electrons in the electron stream are drawn toward it and whereby the electric field produced by the several
30 electrodes is not distorted.

As indicated at 17 in Fig. 1, the path of the electron stream is clearly visible on the screen 12. Although the willemite particles appear widely spaced apart, as shown in the magnified
35 view in Fig. 3, actually they are so close together that when the tube is in operation the electron path appears to the naked eye as a sharply defined trace of solid color on the screen.

Although only one specific screen construction
40 has been described, our invention is not limited to such construction, as any other suitable method may be employed for making the screen secondary electron emissive. For example, willemite may be sprayed directly upon mica to form a
45 willemite screen, no silver being used, and the willemite then made sufficiently electron emissive by treating it with barium. This may be done by mounting the willemite screen in the tube in which it is to be used and then exploding a capsule of barium getter in the tube. As the barium
50 will deposit on the walls of the tube, it is driven over to the willemite screen by heating the tube walls with a torch.

It may be noted that for demonstration tubes
55 it usually is desirable to spray with willemite

the inner surfaces of electrodes 4, 6, 7, 8, 9 and 11, that is, the electrode surfaces facing each other as in the case of the screen 12; only partial coverage of the electrodes 4 and 6 with willemite is desirable.

In Fig. 4, we have shown our invention applied to a different type of tube. It comprises an evacuated envelope 21 having therein an indirectly heated cathode 22, a control electrode 23, and an anode 24. If the anode 24 is maintained at a suitable positive potential, the electrons from the cathode 22 travel toward it as a beam of electrons, the beam spreading out as the electrons approach the anode. The amount the beam spreads out depends upon the potential of the control electrode 23. This may be demonstrated by supporting a secondary electron emissive fluorescent screen 26 in the path of the electron beam, the screen being constructed as previously described. As indicated at 27, the path of the electrons is visible on the screen.

It will be understood that there are various uses for our invention other than those described. The tube shown in Fig. 4, for example, may be employed as a tuning indicator for radio receivers.

We claim as our invention:

1. The method of making a fluorescent screen which comprises forming silver globules upon an insulating surface, forming upon the resulting silver globule surface a coating of fluorescent material in the form of minute particles spaced apart to form a discontinuous coating, and then sensitizing said globules to make them secondary electron emissive.

2. An electric discharge device comprising an evacuated envelope having therein a source of electrons and an element for utilizing said electrons, means for directing said electrons along a certain path toward said element, and a fluorescent screen positioned parallel and close to said electron path, said screen being sufficiently secondary electron emissive to prevent it from acquiring a negative charge and having thereon a coating of fluorescent material which appears to the naked eye to be a uniform coating but which covers only a fraction of the screen surface, said fluorescent screen comprising an insulated supporting surface having silver globules thereon sensitized with an alkali metal and having only a portion of said globules covered with minute particles of fluorescent material substantially uniformly distributed over the screen surface.

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