Aug. 30, 1938.

B. C. GARDNER

2,128,582

PHOTOELECTRIC SURFACE

Filed Aug. 18, 1936

Fig. 1.

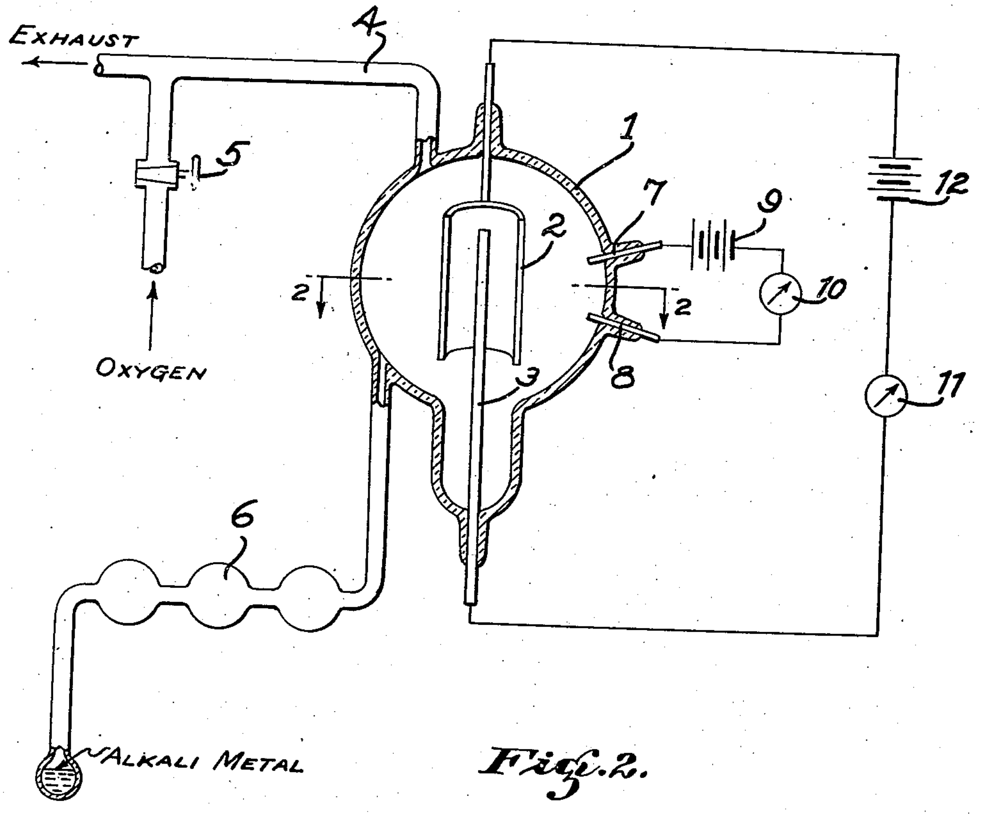
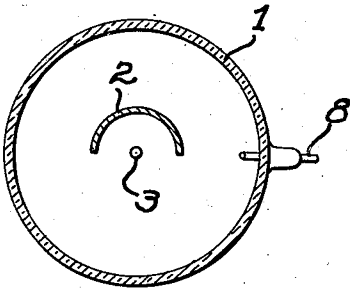


Fig. 2.



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PHOTOELECTRIC SURFACE

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Francisco, Calif., a corporation of California

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5 Claims. (Cl. 250—27.5)

My invention relates to photoelectric tubes and, more particularly, to a means and method for obtaining a photoelectric surface of high sensitivity, and my method in its preferred form is suitable for the production of photosurfaces highly sensitive in the red end of the spectrum.

Among the objects of my invention are: To provide a means and method of obtaining a photosensitive surface of high efficiency; to provide a means and method of obtaining photosurfaces highly sensitive in the red end of the spectrum; to provide a means and method of preventing leakage in the photoelectric tubes; to provide a means and method of neutralizing free alkali metal in a photoelectric tube; to provide an improved means and method of sensitizing a photoelectric surface and to provide a highly sensitive caesium-silver oxide photo tube.

My invention possesses numerous other objects and features of advantage, some of which, together with the foregoing, will be set forth in the following description of specific apparatus embodying and utilizing my novel method. It is therefore to be understood that my method is applicable to other apparatus, and that I do not limit myself, in any way, to the apparatus of the present application, as I may adopt various other apparatus embodiments, utilizing the method, within the scope of the appended claims.

In the drawing:

Figure 1 is a diagram showing a tube and apparatus setup by which the photosurface of my invention may be formed.

Figure 2 is a cross-sectional view of the tube shown in Figure 1.

As my invention relates in its preferred form to the formation of a photoelectric surface which is deposited upon an oxide layer, I prefer to describe the forming of my surface in conjunction with what is known as a caesium-silver oxide tube.

Heretofore, in making such tubes a silver surface is oxidized and caesium admitted thereafter, meanwhile checking the photoelectric emission from the tube, and the admission of caesium is stopped as soon as the photoelectric emission reaches a predetermined and desired value. At this point there is considerable free caesium left within the container, and this free caesium is highly detrimental to the final operation of the device, inasmuch as leakage currents develop due to the fact that caesium metal is a good conductor of electricity even in extremely thin films. It is customary, therefore, after the tube has reached the desired sensitivity, to rebake the container until the free alkali metal is removed from the tube. The alkali metal which has been deposited on the silver oxide is retained therein and is not re-evaporated during this baking process, and the sensitivity of the formed surface does not suffer appreciably by the baking.

It is, however, extremely important in the prior art devices that no excess caesium be admitted beyond that needed to properly sensitize the surface inasmuch as the output sensitivity will be lowered and cannot be restored under the ordinary procedure. The prior art processes, therefore, are all characterized by requiring constant attention and careful supervision, and in spite of such supervision tubes vary greatly in their sensitivity.

My method allows the use of excess quantities of alkali metal, the sensitization being accomplished by oxidization of the final deposit. In addition, I do not remove the excess alkali metal from the tube, but simply change it from a metal to an oxide, the latter being non-conductive, thus leakage is eliminated.

The more detailed advantages of my new method may be more fully understood by a direct reference to the formation of a caesium-silver oxide surface in accordance with the method. Referring to the drawing:

An envelope 1 is provided with a cathode foundation member 2 and an anode 3. The tube is sealed onto an exhaust line 4 to which oxygen may be supplied through a stopcock or other suitable means 5. Caesium metal is placed in a still tube 6 by which the metal may be passed into the vessel.

In the normal formation of a caesium-silver oxide surface I prefer to use for a cathode foundation pure electrolitic silver rolled into sheet form. Before being mounted in the envelope I prefer to clean the eventual active surface with a mild abrasive, such as that known in the trade as "Bon Ami", and thoroughly wash the plate. The silver plate is then etched by passing thereover a hydrogen flame until by eye the entire surface shows a matte effect, indicating a thorough and uniform etching. This silver plate is then placed within the vessel 1 and the tube is evacuated and baked. After the electrodes have been thoroughly cleaned of adsorbed gases, oxygen is admitted to the tube under low pressure and a glow discharge is struck between anode 3 and cathode 2. This glow discharge may be either alternating current or direct current. The etched surface is then watched as it passes through a number of color changes, and I have found that the most efficient oxide layer is formed when the surface passes through yellow, brown, blue white, back to yellow, and then into a second brown. When the second brown color is obtained the tube may be pumped out and rebaked at 200° for ten minutes. The caesium metal is then distilled in through the still tube 6 in excess quantity, and no attempt need be made to put in any definite quantity, though I usually prefer to admit about twice the amount which would normally be needed. The silver turns a bright golden color due to the deposition on the oxide layer of a relatively large amount of metallic caesium. Under normal circumstances this relatively large amount of metallic caesium would run or flow on the cathode plate, but I have found that the etching step described above prevents such flow and consequent irregularities. The etching insures that the caesium will be deposited uniformly upon the silver oxide. At this stage the cathode is sensitive only to the point that metallic caesium would give a photoelectric, response and in addition, the walls of the tube have enough metallic caesium thereon to cause sufficient leakage to prevent proper operation of the device.

I then readmit oxygen, and the caesium surface changes color and appears almost black. Oxygen again is admitted until all conductivity along the walls of the device is killed. If no convenient connection can be made within the tube to determine whether or not conductivity across a link is destroyed, then I may prefer to insert a pair of spaced contacts 7 and 8 and join them by a circuit concerning a battery 9 and an indicating device 10. However, this latter is only necessary in specific cases where contacts for determining leakage cannot readily be obtained with the normal electrode structure.

Normally all leakage conductivity due to metallic caesium is destroyed before the photo-current is developed to its maximum, and consequently, after conductivity has been destroyed, additional oxygen is slowly added, meanwhile checking the photo-current in an indicating device 11. It is found that the photoelectric current will increase up to the point when thermionic emission starts. It is easy, of course, to define where this point is, by intermittently exciting a light source adjacent the tube. If the current in the photo-current device indicator 11, joining the anode and cathode through photo anode battery 12, persists after the light is turned out, then the thermionic emission point has been reached, and I have found that the peak of the photoelectric current is reached when the thermionic current is between zero and one hundred microamperes from a surface area of approximately nine square inches at 200° centigrade.

The process as above described produces photoelectric surfaces having a considerably higher sensitivity than the usual caesium-silver oxide surfaces, and the surfaces produced have a remarkable uniformity. Furthermore, I have found that the process is not critical and may be repeated in case a slip in procedure takes place. For example, if oxygen is admitted in the final step in too great a quantity, so that the photo-current passes its peak and starts to drop, the sensitivity of the surface may be restored by admitting a little more caesium and re-oxidizing as described for the original caesium deposit. Thus I have been able to produce surfaces having not only a high sensitivity, but which are reproducible in quantity. Steps which are hard to control, such as the admission of caesium, are no longer critical, and the steps which are easy to control, such as the admission of oxygen, are such that they may readily be checked as to the action thereof.

The high sensitivity of the surface, and in addition, the uniformity of surface with respect to adjacent areas of the cathode, together with complete lack of leakage due to the non-conductivity of caesium oxide, make the surface I have just described ideally adapted for use in television dissector tubes utilized for electronic scanning. It should also be pointed out that the process is ideally adapted for use in conjunction with mosaic surfaces. For example, if the basic silver foundation is in the form of a silver mosaic, and this mosaic be oxidized and caesium admitted in accordance with my process herein described, then it is obvious that when the final oxygen treatment is administered the metallic caesium between the silver islands is oxidized, and that therefore the islands will be electrically distinct. One of the main problems of forming a photoelectric mosaic under present methods is the elimination of caesium coating between islands.

It should also be pointed out that while I have described my process as used in conjunction with a silver foundation which is self-oxidized, and having a particular alkali metal, namely, caesium, deposited on the oxide, it is obvious that my method may be applied to other equivalent foundation materials upon which caesium will deposit, and that alkali metals, other than caesium, can be used for the photosensitive material.

I claim:

1. The method of forming photoelectric surfaces in an envelope comprising forming therein a substance with which alkali metal will combine, admitting an excess of alkali metal, admitting oxygen until all uncombined metal is oxidized, and continuing the admission of oxygen until thermionic emission is obtained from said surface at 200° centigrade.

2. The method of forming photoelectric surfaces in an envelope comprising depositing a silver surface therein, oxidizing said silver surface admitting an excess of alkali metal, admitting oxygen until all metal other than that directly associated with said silver oxide is changed to alkali metal oxide, and continuing the admission of oxygen until thermionic emission appears from said surface at 200° centigrade.

3. A photoelectric surface comprising in order a silver layer, a silver oxide layer, a caesium metal layer, and a caesium oxide layer.

4. A method of preparing a silver surface to receive a deposit of photoelectric material which comprises the step of etching said surface in a hydrogen flame.

5. A method of preparing a silver surface to receive a deposit of photoelectric material which comprises the step of playing a hydrogen flame on said surface until a uniform etching thereof results.

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