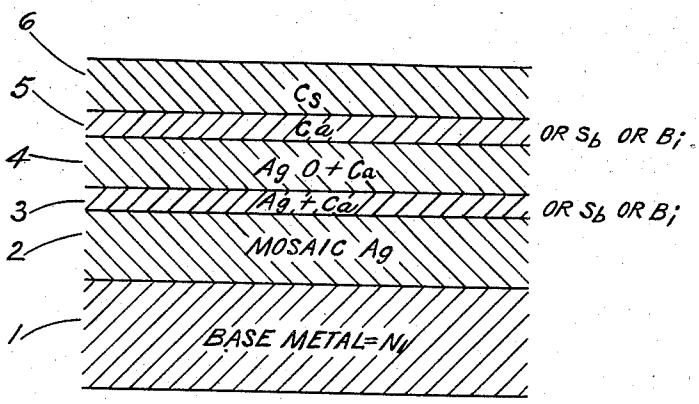
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PHOTOELECTRIC TUBE AND METHOD OF MANUFACTURING SAME

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INVENTOR.
ARTHUR BRAMLEY
BY
J. F. Clerk
ATTORNEY

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PHOTOELECTRIC TUBE AND METHOD OF MANUFACTURING SAME

Arthur Bramley, Long Branch, N. J., assignor, by mesne assignments, to Philco Corporation, Philadelphia, Pa., a corporation of Pennsylvania

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The present invention relates to the manufacture of photoelectric tubes, more particularly to the manufacture of gas-filled photoelectric tubes having cathodes provided with surfaces photosensitive primarily to visible radiation.

It is an object of the invention to provide a photoelectric tube possessing greater light response and being less liable to fatigue than tubes heretofore produced.

Another object is the provision of photoelectric tubes having much greater uniformity in sensitivity than those of the prior art, thus permitting the standardization of the tube for use under definite service conditions.

Another object of the invention is the provision of a method of forming a composite cathode coating comprising depositing alternate layers of conductive and semi-conductive materials upon a cathode base, the character of said materials being such that they become impregnated with one another, forming a mixture capable of reducing the positive charges formed on the active surface of the photo-cathode when photo electrons are emitted under illumination.

Another object is the provision of a method of forming a composite photo-cathode coating consisting of alternate layers of conductive and semi-conductive layers of metallic elements or compounds, the thickness and the rate of formation of which layers may be controlled, whereby the sensitivity of the photo-cathode may be predetermined within a relative close range as contrasted with the wide variations in the sensitivity of photoelectric tubes presently manufactured.

Other objects will manifest themselves as the description proceeds.

According to the present invention the positive charges formed on the active surface of the photo-cathode can be reduced by a metal compound of suitable conductivity impregnated into a layer or layers of a semi-conductor. By the reduction of these charges it is possible to produce a photoelectric tube having greater sensitivity and quicker response.

Therefore, a feature of the invention is using a plurality of conductive and semi-conductive layers of elements or compounds which are alternately deposited upon a cathode base and are of such a character that the several conductive layers impregnate the semi-conductive layers, and conversely they conductively impregnate one another. The several materials, both semi-conductive and conductive, may be considered to flow into one another so that the conductive materials form threads or filaments, extending from the

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outer surface through the several layers to the base cathode. The outer layer is formed of cesium vaporized onto this interspersed mixture of conductive and semi-conductive materials.

The invention will be more fully understood by the following description and reference to the accompanying drawing.

The drawing schematically illustrates a greatly exaggerated section of the photo-sensitive coating, as it would appear when finally deposited upon a cathode metal base, as a result of practicing the present invention.

In practicing the invention the base metal 1 of the photocathode may consist of nickel which is fired in hydrogen at 900° C. for ten minutes. This is an important step generally omitted in prior art practices because during the firing process the cathode base occludes hydrogen presumably because of the porosity of the nickel and it is necessary to free the nickel of this occluded hydrogen in order to prevent it from contaminating the addition materials which compose the coating.

As set forth above the cathode coating is composite in nature, i. e., consisting of not only a plurality of layers, but layers of semi-conductive as well as conductive materials. In making the choice among the metallic compounds or elements which may be considered suitable for application onto the semi-conductive layer overlaying the cathode metal base, care must be taken that neither such materials nor the materials of the semi-conductive layers form any undesirable component or compounds which may obstruct or upset the effective combination. This limits the choice to antimony, bismuth and calcium, all of which form stable hydrides.

A silver mosaic layer 2, particles of which are conductive, but spaced from each other is formed on the base metal 1 by reduction of silver oxide. This may be applied in any well-known manner. This layer, being a mosaic, is termed non-conducting. The cathode is then sealed into a conventional envelope (not shown) and calcium is vaporized onto the mosaic layer 2 in an oxygen atmosphere at an optimum pressure of about one mm. of mercury in the envelope. The envelope is then exhausted.

During this step the outer cathode surface becomes a mixture of calcium and silver which forms a relatively thin layer 3, consisting of silver to which calcium has been added and deposited on the mosaic layer 2. Layer 3 is a conducting layer. Concurrently layer 4 is formed, consisting of a mixture of calcium and silver oxide. If this

layer is examined microscopically, it will be found that the surface material is silver oxide with particles of calcium interspersed throughout the mixture. This layer 4 is non-conducting. Another layer 5, of calcium may be deposited upon layer 4. Layer 5 is a conducting layer.

For the outer surface of the coating, a layer 6 of cesium is vaporized onto the layer 5 of calcium, resulting in a non-conducting layer of cesium oxide with particles of calcium. The most satisfactory results have often been obtained by evaporating the cesium, cooling and repeating the evaporization onto the initial layer 5 in which a portion of the calcium has now reacted with the hydrogen, thus tending to stabilize the sensitivity of the photoelectric tube.

Following the formation of the cathode coating, the envelope may be filled with argon at about one mm. pressure and the tube sealed off.

The steps described separately comprise the complete method, and generally stated, consist of using calcium or its equivalents antimony or bismuth as conductive film-forming materials alternated between non-conducting layers of metallic elements or compounds. These substances unite with any hydrogen occluded in the base metal cathode 1, forming stable hydrides.

It should be noted that the materials calcium, antimony and bismuth may be used singly, interchangeably or in any desired combination, but I prefer the use of calcium only because of its ease of processing.

From the foregoing it will be observed that the photo-cathode coating contemplated herein comprises one or more layers of conductive and semi-conductive materials alternated during the deposition thereof. By selecting the non-conductive compounds with respect to their conductivity and controlling the thickness of the several layers, and by correspondingly dimensioning the conductive elements as well as governing the rate of formation of the surface layer of the several metallic elements or compounds and the temperature at which the deposition takes place, a photo-sensitive surface may be built up having a sensitivity coming substantially within a pre-selected range, thus insuring the regularity or uniformity of the sensitivity of the photo-tube so that it is adapted for use under definite service conditions at will. Also the spectral distribution curve of the phototube may be controlled by the particular way in which the silver, cesium and either calcium, bismuth or antimony are deposited and in particular the temperature at which the deposition takes place.

It is obvious to those skilled in the art that the method contemplated herein for forming a composite cathode coating may be varied in the number of layers comprising the coating as well as the arrangement or alternation of the conductive and semi-conductive elements or compounds, but it is my intention to cover all such modifications as come within the scope of the appended claims.

What is claimed is:

1. A photoelectric tube of the gas-filled type comprising a cathode having a photo-sensitive surface formed upon a base metal, said surface comprising a layer of mosaic silver formed upon the base metal from reduced silver oxide, a layer consisting of a mixture including calcium deposited upon said mosaic, a layer of silver oxide formed upon and within said mixture, a layer of calcium deposited upon said silver oxide, and an outer layer of cesium deposited upon said layer of calcium.

2. The photo-sensitive tube claimed in claim 1, wherein the materials of the several layers are interspersed.

3. The method of preparing a composite cathode coating having a photo-sensitive surface comprising forming a layer of mosaic silver upon a metallic base member from reduced silver oxide, sealing the cathode into a discharge tube, vaporizing onto the mosaic layer a layer of calcium in an oxygen atmosphere which forms a mixture of calcium and silver oxide with the calcium interspersed throughout the mixture, and finally vaporizing an outer layer of cesium upon said layer of calcium resulting in the formation of cesium oxide particles adjacent the silver oxide mixture.

4. The method of making a photoelectrically sensitive surface which includes the steps of firing nickel in hydrogen at an elevated temperature, forming a silver mosaic on a surface of the nickel, depositing on said silver mosaic—in an oxygen atmosphere—a layer of a metal which forms a stable hydride, and depositing a layer of cesium upon the aforesaid layer of metal.

5. The method of making a photoelectrically sensitive surface which consists in firing a metallic surface in hydrogen at an elevated temperature, forming a mosaic of conducting particles upon the supporting surface, depositing on said mosaic—in an oxygen atmosphere—a layer of metal which forms a stable hydride, and depositing a layer of an alkali metal upon the layer of metal immediately aforesaid.

6. An electron emissive cathode including: a conductive supporting surface having a silver mosaic thereon, a conductive layer of silver and a hydride-forming metal on said mosaic, a semi-conductive layer of silver oxide upon said conductive layer, said semi-conductive layer being interspersed with particles of said hydride-forming metal, a conductive layer of said hydride-forming metal on said semi-conductive layer, and a layer of an alkali metal on said last mentioned conductive layer.

ARTHUR BRAMLEY.

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