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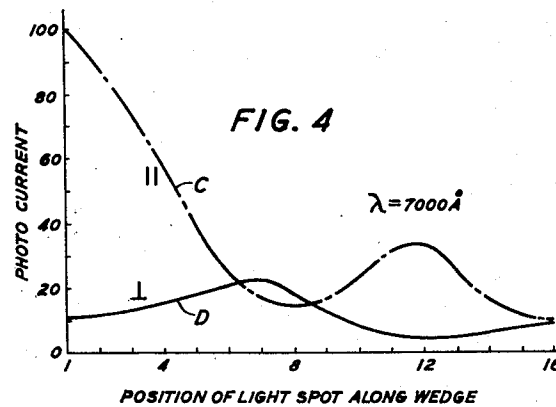
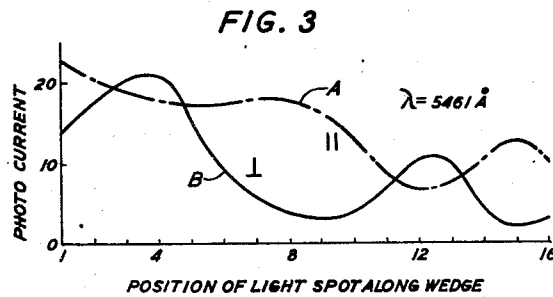
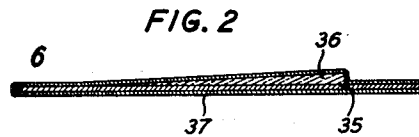
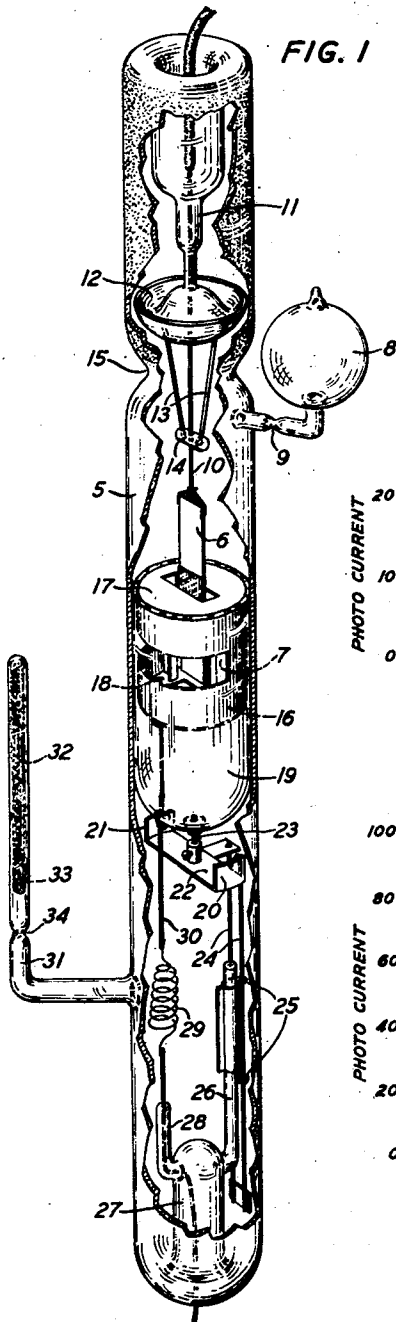
H. E. IVES

1,969,558

ELECTROOPTICAL DEVICE

Filed March 10, 1933

2 Sheets-Sheet 1



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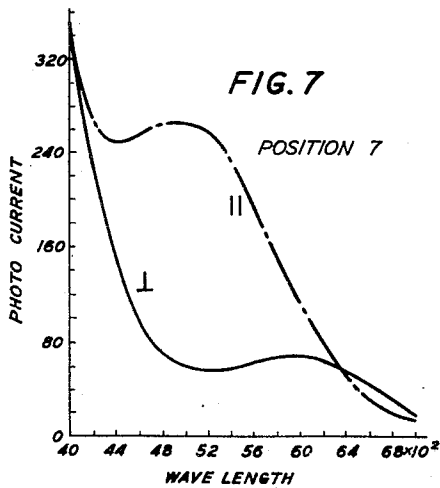
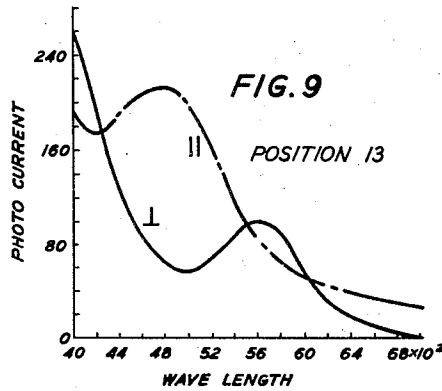
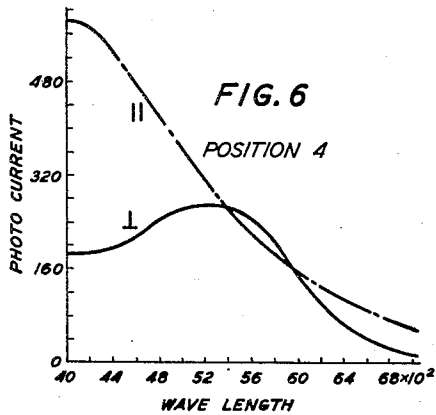
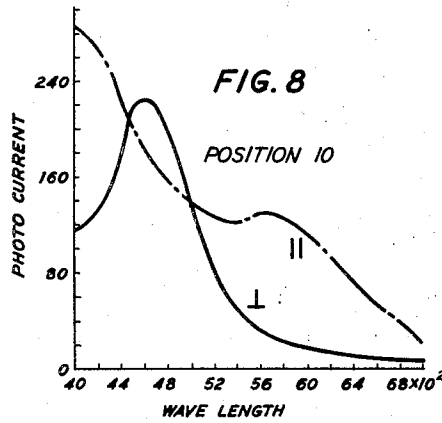
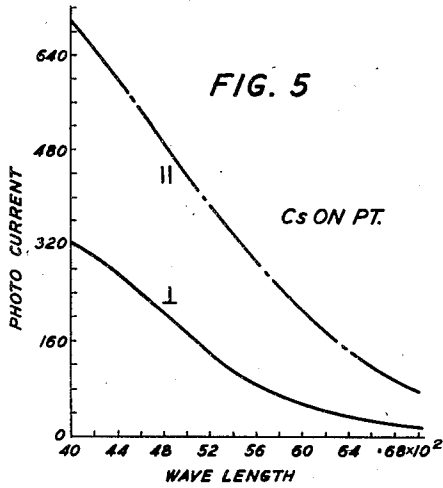
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1,969,558

ELECTROOPTICAL DEVICE

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Application March 10, 1933, Serial No. 660,250

8 Claims. (Cl. 250—27.5)

This invention relates to electro-optical devices.

An object of the invention is to provide a novel and useful light sensitive cathode. Other objects will be apparent from what follows.

An example of practice, described by way of illustration, is a photoelectric tube. It comprises a glass container having a tubular portion of considerable length. Mounted at one end of this portion is a rectangular elongated polished platinum plate, extending along and in coincidence with the axis of the tubular portion and connected to a sealed-in conductor at that end of the tube. This plate carries a wedge-shaped piece of quartz on one of its faces. A thin transparent film of cesium is deposited on the face of the quartz away from the platinum and also on that portion of the platinum plate not covered by the quartz. A cathode is thus formed, the light sensitive surface of which at different points lies at different distances from the supporting metallic plate. An anode connected to another sealed-in conductor at the other end of the tubular portion is movable into operative relationship with the cathode.

The invention will now be described more in detail having reference to the accompanying drawings.

Fig. 1 is a perspective drawing of a photoelectric tube illustrative of the invention.

Fig. 2 is a fragmentary showing of the cathode in longitudinal cross-section.

Figs. 3 and 4 are curves showing the variations in response to light of two different wave lengths at various positions along the cathode.

Figs. 5 to 9 are curves showing the distribution of photoelectric current with wave lengths at different positions along the wedge.

Referring now to Fig. 1 the assembled photoelectric tube comprises an evacuated glass container 5 having a cathode 6 and an anode 7. The container 5 is provided with a side tube 8 into which a small amount of cesium had been introduced subsequent to evacuation of the container but prior to sealing off from the pump station. A constriction 9 in the side tube practically eliminates spontaneous deposition of cesium from the side tube in the tube at room temperatures.

The cathode 6 comprises an elongated polished platinum plate the upper end of which is connected to a conductor 10. The conductor 10 is sealed-in to a reentrant tube 11, which carries a glass baffle plate 12 and two small glass rods 13. These rods 13 are sealed to the conductor

10 by the glass bead 14. This construction reduces vibration of the cathode 6.

The baffle 12 does not contact at its edges with the container 5, which has a constriction 15 just below baffle 12. The inside surface of this upper portion is sandblasted to increase the leakage path from the lower portion of the container 5 to the sealed-in conductor 10.

The anode 7 comprises a hollow metallic cylindrical member 16, partially closed at top and bottom by discs 17 and 18, each of which has a rectangular slot to permit passage of the cathode 6 therethrough without contacting therewith. Two metallic strips extend between the discs, one at either end of these slots. This member 16 is positioned within a glass tube 19 which is closed at its lower end and adapted to slide up and down within the tube container 5. An aperture in the side of the cylindrical member 16 allows a beam of light to be incident on the cathode 6, while the cathode is inside the anode 7.

Movement of the anode 7 may be effected with a magnet operating upon two iron armatures 20 and 21 secured to a metallic strip 22. This strip 22 is fastened to a pin 23 which is sealed into the glass tube 19. The tube 19 is prevented from rotating within the container 5 by guide wires 24 secured to the strip 22 and passing through guides 25 supported on a glass rod 26, which rod in turn is supported on reentrant tube 27.

Electrical connection with the anode 7 is obtained through sealed-in conductor 28, extensible conductor 29 and conductor 30 which itself is sealed through tube 19.

The side tube 31 contains charcoal 32 held in place by a glass wool plug 33 positioned above the constriction 34. The purpose of the charcoal is to absorb residual gas and so improve the vacuum.

The lower portion of cathode 6 is shown in cross-section in Fig. 2. It consists of a platinum plate 35 on one face of which there is deposited a quartz wedge 36, all of the exposed surfaces then being covered with a very thin film of cesium 37. The thickness of the quartz wedge 36 and the film of cesium 37 is greatly exaggerated for the purpose of illustration.

The wedge 36 is produced by evaporating quartz from a tungsten filament sheathed in quartz beads and causing it to deposit on the face of the platinum plate 35. The evaporation is carried on in a highly evacuated chamber. That portion of the plate where the thickest deposit of quartz is desired, is located closest to the filament, other portions being located progressively farther away.

The cesium film 37 is formed by spontaneous deposition at room temperature. A small amount of cesium is driven in from the side tube 8 by the application of heat to this tube. The anode 7 is moved downward to expose the platinum plate 35 and quartz wedge 36. The cesium film 37 then forms by spontaneous deposition. Preferably the amount of cesium employed is so small that the films are very far from being fully developed, but nevertheless are sufficiently sensitive for accurate measurement.

The photoelectric current response characteristic of the cathode 6 is shown by Figs. 3 and 4. The units shown for photo current are arbitrary, so that the data is merely relative. The abscissae represent successive arbitrary positions along the quartz wedge, position 1 being near the thinnest portion. At position 1 the wedge is approximately 2800×10^{-8} cm. thick, while at position 12 it is approximately 6660×10^{-8} cm.

The curves of Fig. 3 were obtained with light having a wave length λ of 5461 Ångström units. The curves of Fig. 4 were obtained with light having a wave length λ of 7000 Ångström units.

Curves A and C were obtained with the light beam polarized with the electric vector parallel to the plane of incidence; while curves B and D were obtained with the light beam polarized with the electric vector perpendicular to the plane of incidence. Each of these four curves were obtained with the light incident at an angle of 60 degrees.

The distribution of photoelectric current with wave length at different positions along the wedge-shaped cathode is shown by the curves of Figs. 5 to 9. In Fig. 5 there is shown the variation of photoelectric emission with wave length for cesium on clean platinum, that is, from a section of the cathode which was shielded from the quartz carrying filament. This shows the rise of emission toward shorter wave lengths and the somewhat greater emission for light polarized with the electric vector parallel to the plane of incidence which is characteristic of the very thin film of cesium on platinum. No maxima or minima of emission occur in the wave length region explored. In Figs. 6 to 9 there are shown wave length distribution curves for positions 4, 7, 10 and 13 along the wedge. These are of quite different and extremely varied character, exhibiting not only pronounced maxima and minima of emission through the visible spectrum but periodical reversals of the strength of the photoelectric current for the two planes of polarization.

For illuminating the tube, a tungsten filament lamp with a quartz window was used in conjunction with a quartz monochromator and a quartz Rochon-double image prism for polarizing the light. A variable angle prism made of two fused quartz wedges was introduced in the path of the double beam from the quartz Rochon prism, and shift from one plane of polarization to the other was made by rotation of the variable angle prism. The light spot used was about one millimeter in diameter. The optical adjustment was such that shifting of the spot on turning from one plane of polarization to the other was usually imperceptible. The photoelectric currents were read on a Compton electrometer using a high resistance leak by the steady deflection method.

In a modified form of this invention the layer of quartz may be of substantially uniform thickness. The thickness is then so chosen as to give a desired spectral sensitivity distribution.

In operation the photoelectric device herein disclosed may be used in the same manner as photoelectric tubes of the prior art by impressing light upon its cathode to produce photoelectric currents under control of the light so impressed. In the particular embodiment illustrated various operating characteristics may be utilized by proper choice of the character of the light and the position on the cathode where the light impinges. This device is not limited in use to the character of light specifically mentioned in the specification, since, in accordance with the disclosed behavior, it is obvious that various operating characteristics may be obtained by varying the character of the light and its point of incidence on the cathode and that, if it is desired to utilize some form of light not specifically mentioned above, the operating characteristics can be determined by the methods disclosed herein.

What is claimed is:

1. A cathode for a photoelectric device comprising a flat specular surface, a transparent wedge mounted on said surface face to face, and a thin transparent film of photoelectric material on the other face of said wedge.

2. A cathode for a photoelectric device comprising a polished platinum plate, a quartz wedge mounted on one face of said plate, and a thin transparent film of photoelectric material on the other face of said wedge.

3. A cathode for a photoelectric device comprising a polished reflecting surface, a layer of transparent refracting material on said surface, and a thin transparent film of photoelectric material on the exposed surface of said refracting material.

4. A cathode for a photoelectric device comprising a polished reflecting metallic surface, a layer of quartz deposited on said surface, and a thin transparent film of photoelectric material on the exposed surface of said quartz.

5. A cathode for a photoelectric device comprising a specular metallic surface, a layer of transparent refracting material on said surface having a thickness of the order of the wave lengths of visible light, and a thin transparent film of photoelectric material on the exposed surface of said refracting material.

6. A cathode for a photoelectric device comprising a polished platinum plate, a layer of quartz deposited on one face of said plate, and a thin transparent film of cesium on the exposed surface of said quartz.

7. A cathode for a photoelectric device comprising a polished platinum plate, a quartz wedge deposited on one face of said plate, and a thin transparent film of cesium on the exposed surface of said quartz.

8. A method for producing a cathode for a photoelectric device which comprises vaporizing quartz, causing said vapor to deposit on a polished platinum plate, and depositing a thin transparent film of light sensitive material upon said quartz in vacuo.

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