Dec. 30, 1958 S. C. PEEK, JR 2,866,906

PHOTOCELL DEVICES

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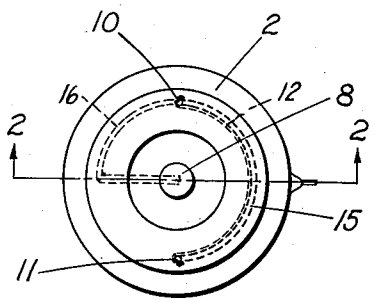


FIG. 1

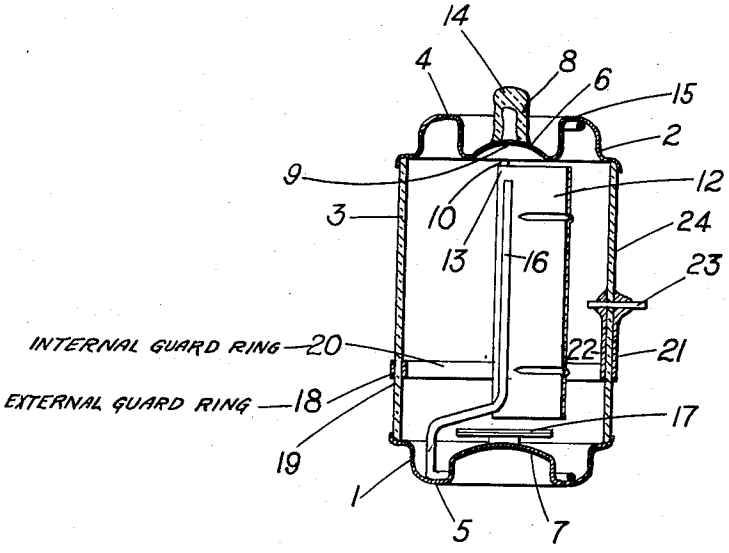


FIG. 2

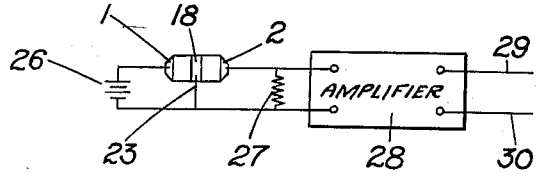


FIG. 3

INVENTOR:
SANDFORD CHRISTOPHER PEEK
BY Laurence Burns,
ATTORNEY

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PHOTOCELL DEVICES

Sandford C. Peek, Jr., Hamilton, Mass., assignor to Sylvania Electric Products Inc., Salem, Mass., a corporation of Massachusetts

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1 Claim. (Cl. 250—200)

This invention relates to photocells, and especially to photocells for responding to very low levels of illumination.

Under such conditions, leakage currents across the glass walls of the photocell are often of the same order of magnitude as the signal current, that is, as the cathode current. To reduce such current, the lead-in connections to the anode and cathode of the cell are often made on opposite ends of the photocell envelope, which is generally in the form of a tube.

The leakage reduction obtained by placing the connections on opposite sides of the tube is not ordinarily sufficient, because moisture and dirt can still collect on the outside of the envelope and cause excessive leakage. However, I have found that the use of a guard ring on the outside surface of the glass at a point between the ends of the tube will reduce or eliminate the leakage from that source.

But there are also leakage paths from anode to cathode inside the envelope; the most important of which is due to a conducting film of the photosensitive metal deposited on the inner wall of the glass, the deposited material, for example, being material evaporated from the cathode during processing. I find that the effect of such internal leakage currents can be reduced or eliminated by a ring of conducting material on the inside surface of the envelope, a connection being provided from said conductive ring through the envelope to the exterior thereof.

The rings can be connected to ground, so that complete grounding of the internal and external leakage currents is obtained.

Other objects, fixtures and advantages of the invention will be apparent from the following description, taken in connection with the accompanying drawing in which:

Fig. 1 is an end view of a photocell according to an embodiment of the invention;

Fig. 2 is a sectional view of the photocell; and

Fig. 3 is a schematic diagram of a circuit in which the tube is used.

In Figs. 1 and 2 the metal end caps **1, 2** are sealed to each end of the tubular glass envelope **3**, as shown for example in U. S. Patent 2,082,616, granted June 1, 1937, to Cartun, or in some other manner, such sealing being well known in the art. Each of the caps has a raised annular portion **4, 5** intermediate its center and circumference, surrounding a central concave portion **6, 7**. From cap **2** an exhaust tube **8** is sealed at one end to an opening **9** in the center of the concave portion **6**, the other end **14** of the exhaust tube being sealed off in the manner customary in the art.

Support wires **10, 11** are welded to the interior of end cap **2** and support the curved silver plate **12**, the longitudinal edges **13** of the plate being curled around the longitudinally extending wires **10, 11** and welded thereto. Although the later are referred to in the plural, there may be a single wire having an arcuate portion **15** fitting in the annular groove **4** of end cap **2** and having ends

extending longitudinally of the tube and in a plane perpendicular to that of the arcuate portion **15**.

The curvature of plate **12** can be concentric with that of the tubular envelope **3**. An anode **16** in the form of a wire extending along the axis of the tubular envelope **3** and of curved plate **12** is bent outward near the end cap **1** and has an arcuate portion extending into annular groove **5** and welded thereto. A nickel disk and cup **17** of a standard type containing caesium, and having radial corrugations through which the caesium can be evaporated, is welded to the inside central portion of cap **1**.

A coating of a getter such as stannic oxide is applied to the back surface, i. e. the convex surface, of silver plate **12**.

A metal guard ring **18** is placed on the outside surface **19** of the glass envelope **3** at a position intermediate the ends thereof. A similar ring **20** is placed on the inside surface of the glass envelope **3**, preferably in register with the outside ring **18**. Metallic connections **21, 22** extend respectively from rings **18, 29** to a lead-in wire **23** sealed through the wall **24** of glass envelope **3**. The lead-in wire **23** is preferably sealed through the wall **24** in back of the silver plate **12**, that is on the wall **24** facing the convex side of plate **12**.

The rings **18** and **20** can be painted onto the outer and inner surface of the glass envelope **3**, the paint used being, for example, a silver paint of a type well known in the art, for example of the type requiring firing at about 1000° F. after application, such types being well known and commonly on the market. The metallic connections **21, 22** can also be painted onto the surface of the glass and into contact with the lead-in wire **23**. The latter can be conveniently sealed into the wall **24** of envelope **3** before the latter is sealed to the end caps **1, 2** and before the conections **21, 22** are painted onto said envelope. The rings are preferably placed near one end of the tube for convenience in painting. The painting insures that the rings **18, 20** are in contact with the glass envelope around its inner and outer circumference. The rings can be of metal evaporated onto the glass, if desired, instead of painting, or can be applied in some other manner.

In one embodiment, the glass tube was about one-inch long and about three-quarter inch in outside diameter, with a one-sixteenth inch wall, and the rings **18, 20** were about one sixteenth inch wide and about one-quarter inch from the end of the envelope. The radius of curvature of the plate **12** was about half that of the envelope **3** and the later was about seven-eighths inch long. The lead-in wires **10, 11, 16** were about $\frac{1}{32}$ inch in diameter, and anode lead-in wire **16** extended to about $\frac{1}{16}$ inch from the end of envelope **3** near end cap **2**. The nickel disk **17** was of the type customary in the art and of about one-quarter inch in diameter. The foregoing dimensions of a particular embodiment are given merely by way of example and not by way of limitation. The dimensions and physical structure can be varied, as long as the guard rings **18, 20** are intermediate the ends of the envelope **3**.

In making the photocell, the lead-in wire **23** can be sealed through the envelope **3**, and the rings **18, 20** and connections **21, 22** painted on. The nickel disk **17** and anode wire **16** are welded to end cap **2**, and the support wires **10, 11** welded to end cap **1**. The curved silver plate **12** is then welded to the support wires **10, 11** and the coating of stannic oxide applied to a considerable portion, about ½ inch by ½ inch in the embodiment whose dimensions are given above, of the convex surface thereof. The end caps **1, 2** are then sealed to the envelope **3** in the usual manner, the exhaust tube having been sealed to end cap **1** at one end of said exhaust tube, the other end of the exhaust tube being open at that time.

The open end of the exhaust tube is then sealed to a high-vacuum pump and the envelope evacuated. After evacuation, the concave surface of silver plate **12** is oxidized in the usual manner and then the disk **17** is flashed, for example, by being heated to incandescence with the usual radio frequency "bombarder" or oscillator, while the envelope **3** is heated. The caesium will thus be evaporated and will condense mostly on the silver plate **12**, giving it a sort of straw color. A small trace of caesium may, however, condense on the interior surface of the glass during the processing of the tube. The exhaust tube **8** is then sealed off from the pumping system in the usual manner, leaving the device hermetically sealed.

In using the photocell after its manufacture, the end cap **1** can be connected, as in Fig. 2, to the positive pole of a battery **26**, and the end cap **2** to a high resistance resistor **27**, for example, of about 80 megohms. The negative side of the battery **26** is connected to the other end of the resistor **27**, and so is the lead-in wire **23**, thereby connecting the ring **18**, **20** to what will usually be the grounded side of the circuit. The voltage across resistance **27** is fed into the amplifier **28**, usually of the direct current type, and the amplified output can be taken from the amplifier for use, for example, at output conductors **29**, **30**.

Although the embodiment described above has a photosensitive surface of caesium, the invention is applicable to devices using other materials. The invention is not limited to the embodiment described, as various modifications therein can be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim:

A photocell system comprising an envelope of insulating material, a photosensitive cathode therein for emitting electrons on exposure to incident radiation, said envelope being transparent at least in part to said radiation, an anode for collecting said electrons, connections to said anode and to said cathode at opposite ends of said envelope, a guard ring on the inside surface of said envelope and intermediate the ends thereof, and a lead-in wire connected to said ring and extending through said envelope, a guard ring on the external surface of said envelope and also connected to said lead-in wire, a resistor of high resistance and a battery, the positive pole of said battery being connected to the anode of said photocell, one end of said resistor being connected to the cathode of said cell, the other end of said resistor being connected to the negative pole of said battery and to said guard ring.

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