July 30, 1946. A. E. STAFFORD 2,404,803

SPACE DISCHARGE DEVICE

Filed Jan. 25, 1941

FIG. 1

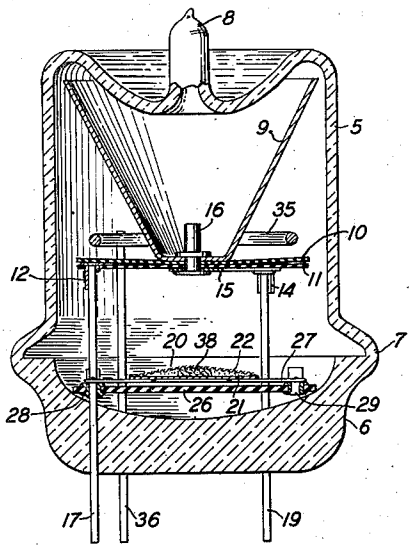


FIG. 2

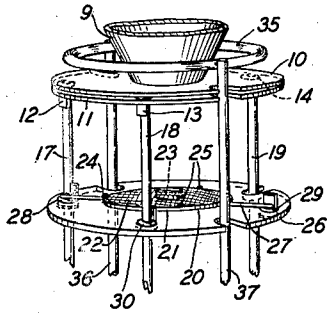


FIG. 3

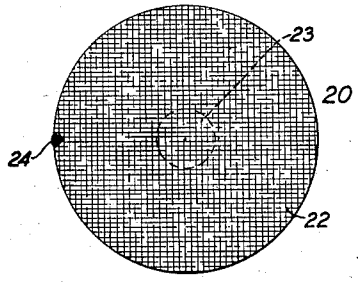
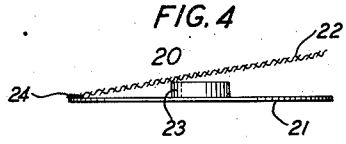


FIG. 4



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SPACE DISCHARGE DEVICE

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12 Claims. (Cl. 250—165)

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This invention relates to space discharge devices and more particularly to photoelectric tubes.

An object of this invention is to provide an improved space discharge device comprising vaporizable material.

A feature of this invention is an improved method and means for mounting material to be vaporized during the manufacture of a space discharge device, such as a photoelectric tube.

In an example of practice illustrative of this invention, a compact photoelectric tube having a silver cathode and an anode is provided with a caesium pellet, chemical reaction of which upon heating produces the caesium for sensitizing the cathode. A novel form of holder for the pellet is used which has many advantages over the forms previously employed. The pellet comprises an intimate mixture of finely divided materials compressed into the form of a short right cylinder. This pellet is mounted between two discs of considerably larger diameter than that of the pellet, one of the discs being stamped from a nickel sheet and the other from nickel wire gauze which has considerable elasticity. In mounting the pellet the wire gauze disc is first laid on top of the sheet disc and the two discs are welded together at a spot near their edges. The pellet is then slipped in between the two discs to a position near their centers; the gauze is bent down; and at least two more welds made so that all of the welds are about equally spaced. The pellet holder is then secured within the tube container in such a way that it can be inductively heated to initiate a chemical reaction of the pellet without injury to the previously oxidized cathode.

There are several advantages in the pellet mounting described above over mountings heretofore known. In the first place any suitable type of pellet may be used since it is not necessary to fuse the pellet to the heater disc as is done in certain types of mountings of the prior art. More intimate contact is obtained between the heater disc and the pellet in the mounting of this invention than is possible in a cup type of mounting where a gauze mesh is set in the cup over the pellet to hold the pellet in place or where a formed metal pellet holder is employed. Because of the intimate contact between the pellet and both the solid and gauze discs, the heat conduction to the pellet is improved and a more uniform chemical reaction takes place throughout the pellet resulting in a uniform amount of caesium being produced in a series of tubes using the same sized pellets. This result is conducive to uniformity in the sensitivity of tubes embodying

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this invention. Another advantage of securing uniform reaction of the pellet is a reduction in the time required for the reaction or "flashing" to take place with consequent lessening of the danger of overheating the oxidized silver cathode during flashing. Furthermore, because of the reduced time of flashing, the pellet may be mounted closer to the cathode without causing undue heating of the cathode and consequently either a more compact tube may be produced or a tube with a larger cathode surface for a given size of container. Because of the use of a gauze disc on top of the solid disc the caesium vapor is emitted through a much larger solid angle than in the case of a cup type of mounting resulting in a more uniform distribution of the caesium on the inside walls of the container. All of these advantages are obtained with a simplified structure which is easy to manufacture at a relatively small cost.

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

Fig. 1 is a longitudinal section of one embodiment of the invention in a photoelectric tube.

Fig. 2 is a perspective showing the relative locations of the elements within the container of Fig. 1.

Fig. 3 is a top view of an improved pellet holder according to this invention in an intermediate stage of its assembly.

Fig. 4 is a side view of the pellet holder of Fig. 3.

Like reference characters are used to refer to identical elements in the several figures.

The embodiment of the invention illustrated in Fig. 1 is a photoelectric tube comprising a generally cylindrical glass container formed in two parts. The molded dish stem 6 below the glass ring seal 7 carrying the electrode assembly constitutes one part and the cylindrical portion 5 above the ring seal 7 with the exhaust tubulation seal-off 8 constitutes the other portion. The seal-off 8 is at a re-entrant portion at the end of the cylindrical portion 5, thus permitting a normal length of seal-off without increasing the overall length of the container. This container in an actual photoelectric tube embodying this invention is approximately one inch in diameter and one and one-half inches long.

Cathode 9 is advantageously formed from substantially pure silver in the shape of a hollow truncated cone, the convex surface of the cathode in the completed tube being photoelectrically sensitive. The small end of the cathode is turned over to fit against one face of a mica disc 10, hav-

ing a central hole. A mica disc 11 also having a central hole and eyelets 12, 13 and 14 is laid face to face against disc 10 on the opposite side from said cathode 9. A nickel ribbon 15 having a hole near one of its ends is laid against the exposed face of disc 11 with the hole coinciding with the holes in the discs. The cathode 9, discs 10 and 11 and ribbon 15 are then secured together by rivet 16. The ribbon 15 is used as a part of the lead-in connection to the cathode 9. The ends of support wires 17 and 18 and cathode lead-in wire 19 are secured to the eyelets 12, 13 and 14, respectively, by welding and the free end of ribbon 15 is also welded to lead-in wire 19.

Caesium for sensitizing the cathode is produced by chemical reaction of a mixture in the form of a so-called caesium pellet. This pellet is mounted in a holder 20 which comprises a nickel disc 21 which is welded to a nickel wire gauze disc 22 of approximately the same size as the nickel disc 21. A caesium pellet 23 is held tightly between the nickel disc 21 and the gauze disc 22.

The novel process of assembling the holder 20 is very simple. The gauze disc 22 is first placed on top of the nickel disc 21 and the discs are welded together at one point 24 near their periphery. The pellet 23 is then placed between the discs by separating them as shown in Fig. 4. The peripheral portions of gauze disc 22 are then pressed against disc 21 and the discs are welded together at a plurality of additional points around their periphery. Two additional welds 25 are shown in Fig. 2.

The pellet holder 20 is supported partly from support wire 17 and partly from mica disc 26 through the intermediary of wire 27. Mica disc 26 is provided with eyelets 28, 29 and 30. Cathode support wires 17 and 18 pass through eyelets 28 and 30, respectively, to which they are welded, thus forming a two-point support for mica disc 26. Wire 27 is welded to the exposed surface of disc 21 of pellet holder 20. One end of wire 27 is welded to eyelet 28 and the other end to eyelet 29 so that disc 21 of pellet holder 20 is separated from the mica disc 26 by a small space.

The anode 35 is a nickel ring surrounding the cathode 9 near its small end. Anode 35 is supported by lead-in wires 36 and 37. These wires pass through notches in mica discs 10, 11 and 26 and are not in contact with these discs so that any deposit of caesium on the mica surfaces does not affect the electrical insulation between the anode 35 and the cathode 9. The mica disc 26, in addition to serving as a support for pellet holder 20, serves as both a heat baffle to prevent injury to stem 6 and a mechanical baffle to prevent caesium from being deposited on the glass stem 6 in the vicinity of the lead-in wires. The mica of these discs is baked at a temperature of 105° C. for about 16 hours. One purpose of this baking is to free the mica of moisture.

The support wires 17 and 18 and lead-in wire 19 for the cathode and the lead-in wires 36 and 37 for the anode 35 are sealed through the molded stem 6 and thus hold the tube elements rigidly in the relative positions shown in Figs. 1 and 2.

The cathode 9 may be sensitized in any well-known manner after the tube structure has been fabricated. An advantageous method is very similar to that described in Patent No. 2,178,227 of M. S. Glass, patented October 31, 1939. The method therein described is modified to take into account the differences in size of the cathodes and the fact that in the photoelectric tube of the

present invention the pellet holder 20 and the conical cathode 9 are coaxially positioned.

Briefly described the method of sensitizing the cathode is as follows:

The tube is baked at about 400° C. to remove occluded gases from the bulb, but this heating does not cause any chemical reaction in the caesium pellet. Oxygen is admitted into the container and the cathode is subjected to ionic bombardment in such a way that the first effect is to produce a heavy layer of silver oxide on the convex surface of the cathode 9 followed by the heating up of the silver cathode and reduction of the layer of silver oxide. This cycle of oxidation and reduction may be repeated after which the oxygen is pumped out of the container. This treatment leaves the convex surface of the cathode clean and slightly rough so that it has a uniform matte finish. A fresh charge of oxygen is admitted and by a succession of discharges of fixed amounts of electricity from condensers, the convex surface of the cathode is oxidized to an amount depending upon the amount of caesium to be introduced. The oxygen is again pumped out of the container. The caesium pellet is then inductively heated to effect a chemical reaction which produces caesium vapor. The high frequency coil used for inductively heating the pellet holder 20 is positioned around the stem 6 with the upper end of the coil at approximately the level of the pellet holder 20. In order to protect the cathode 9 from induced currents a short-circuiting turn in the form of a short length of copper tubing is placed around the cylindrical portion 5 of the container with the lower end at approximately the level of the mica discs 10 and 11. The caesium vapor produced by the chemical reaction is emitted through a wide solid angle through the openings in the gauze disc 22 and condenses primarily on the inner walls of the glass container opposite the cathode 9. The caesium vapor is prevented from directly striking the oxidized surface of the silver cathode 9 by the mica discs 10 and 11. These discs are of such diameter that an annular space is provided between the periphery of the disc and the glass bulb for the uniform migration of the caesium to the cathode surface. The container is then heated in a stream of hot air to a temperature of about 225° C. until the cathode has reached the desired sensitivity. Argon or other suitable gases may be admitted at low pressure to obtain the benefits of gas amplification.

During the flashing of the pellet 23 a large amount of heat is developed. The mica disc 26 protects the glass stem from injury from this heat. After the pellet 23 has been flashed a residue 38 remains as shown in Fig. 1. The mica disc 10 overlies the eyelets 12, 13 and 14 in mica disc 11 and facilitates the obtaining of a uniform electric discharge between the cathode 9 and the anode 35 during the oxidizing process.

As hereinbefore described welding is an advantageous method of rigidly securing the nickel disc 21 and the gauze disc 22 together. Three welds at substantially equally spaced separated points have proved satisfactory. However, a larger number of welds may be used and other methods of holding the edges of the discs 21 and 22 together may be used. Even if the discs are fastened together all the way around their periphery they are considered to be secured at points around their periphery.

Other materials than that mentioned hereinbefore may be used for the cathode and modified

treating methods may be employed. The cathode may consist of copper, the convex surface of which is silver plated. The cathode may also consist of a bimetallic sheet metal of nickel and silver so formed that the silver constitutes the convex surface of the cathode 9. The cathode 9, because of its shape, may be out-gassed by inductive heating and may also be heated inductively to reduce the heavy layer of silver oxide produced during the cleaning and roughening process mentioned hereinbefore. Other materials and modified methods may be used as described in the Glass patent, supra. The ingredients of the caesium pellet are preferably those disclosed in this Glass patent and comprise caesium chromate, chromic oxide and powdered aluminum. These materials react with an exothermic reaction when heated to their reaction temperature.

The form of pellet holder provided by the present invention is particularly useful with a pellet adapted to produce an exothermic reaction. As mentioned hereinbefore the pellet is more uniformly heated to the reaction temperature. The resulting effect is that the whole pellet reacts practically at the same instant and there is no tendency for the pellet to explode, so to speak, and for a part of the pellet to be blown away by the reacting portion before reaction can take place in the blown away portions.

What is claimed is:

1. A space discharge device comprising a container, electrodes supported within said container, and a holder for vaporizable material supported within said container, said holder comprising a substantially flat imperforate metallic disc and an elastic flexed gauze disc rigidly secured to said first disc at points around the periphery of said discs and pressing said vaporizable material firmly against said flat disc.

2. A method of assembling a holder for vaporizable material which comprises placing a substantially flat imperforate metallic disc and an elastic gauze disc of approximately the same size face to face, inserting the material to be vaporized between the two discs, flexing said gauze disc so that the discs touch each other at separated positions near their periphery and firmly press said material against said imperforate disc, and welding the discs together at said separated positions near their periphery.

3. A method of assembling a holder for vaporizable material which comprises placing two substantially flat metallic discs of about the same size face to face with vaporizable material therebetween, one of said discs being of elastic material provided with a large number of apertures therethrough, flexing said elastic material by pressing the said discs together at their periphery, and rigidly securing said discs in metallic contact at a sufficient number of positions around their periphery to place said material under pressure.

4. An arrangement adapted to produce caesium vapor in a photoelectric tube by inductive heating comprising a nickel disc, an elastic gauze disc of approximately the same size as said nickel disc welded to said nickel disc at three or more points approximately uniformly spaced around the edge of said disc, and a compressed pellet containing a mixture of caesium chromate, chromic oxide and powdered aluminum pressed between said discs approximately concentrically therewith and over which said elastic gauze disc is flexed to press said pellet firmly against said nickel disc.

5. A photoelectric tube comprising a container, and means for supporting a chemically reactive pellet within said container, said means comprising a flat nickel disc and an elastic gauze disc of approximately the same size secured to said flat disc by fusion at a plurality of places around the edges thereof and between which discs said pellet is firmly held due to the elasticity of said gauze disc.

6. A photoelectric tube comprising a container, a cathode and an anode supported within said container, and a holder for a compressed pellet of an intimate mixture of finely divided materials which produce caesium vapor by exothermic chemical reaction when heated, said holder comprising a flat nickel disc and a flexed elastic gauze disc of approximately the same size before flexing as said flat disc welded to said flat disc at a plurality of places near the edges of said discs with the pellet located therebetween.

7. An electron discharge device comprising an evacuated container, a cathode at one end of said container, an anode in operative relation to said cathode, a support for sensitizing material comprising a metallic disc and an overlying elastic gauze disc welded to said metallic disc at a plurality of places around the edges of said discs on the side of said disc toward said cathode, a heat resisting baffle supported intermediate said cathode and said support, and a second heat resisting baffle intermediate said support and the adjacent end of the evacuated container.

8. A photoelectric tube comprising a glass container of generally cylindrical shape, a plurality of support wires sealed through one end of said container, a mica disc supported from certain of said wires in a position transverse of said container, a cathode in the shape of a truncated cone supported at its small end on said mica disc and having its large end closely adjacent to the end of the container away from the sealed wires, an anode supported by other of said support wires, a metallic disc also supported from said mica disc support wires on the side of said mica disc opposite from said cathode and parallel to said mica disc, an elastic wire gauze disc overlying said metallic disc on the side toward said mica disc welded at a plurality of points near the edges of said overlying discs, and a pellet of a mixture which produces caesium vapor when heated pressed between said overlying discs.

9. A photoelectric cathode assembly comprising a truncated cone of sheet metal the convex surface of which is silver serving as cathode support, a mica disc approximately as large as the base of said cathode, a rivet securing the small end of the cathode to the center of said disc, means supporting said disc from a plurality of wires sealed in a glass stem, and a holder for a caesium producing pellet comprising a metallic disc and a gauze disc over said metallic disc, said discs being welded together at a plurality of points near the edges thereof with the gauze disc facing said cathode supporting mica disc, said holder being positioned on the side of said mica disc opposite to said cathode and conductively connected to one of said plurality of wires supporting said mica disc.

10. A method of assembling a caesium producing pellet holder for a photoelectric tube which comprises placing a solid metallic disc and an elastic gauze disc of about the same size face to face, welding said discs together at a position near their periphery, separating the discs except at the welded position, inserting a caesium producing pellet between the two discs to a position near their centers, flexing said gauze disc

over said pellet by pressing the separated portions of the edges of said discs together against said pellet, and welding said discs together at additional positions around their edges to maintain pressure on said pellet by said discs.

11. A photoelectric tube comprising a container, a plurality of electrodes including a cathode mounted within said container and an anode also mounted within said container in operative relation to said cathode, a caesium pellet holder also mounted within said container substantially out of heat conducting contact with said cathode, said pellet holder comprising a metallic disc and an overlying gauze disc welded thereto on the side toward said cathode, and a mica disc at least as large as the transverse section of said cathode also supported within said container between the said pellet holder and said cathode.

12. A photoelectric tube comprising a container, a cathode and an anode supported within said container, and a holder for a pellet of an intimate mixture of finely divided materials which produce vapor of a light sensitive substance by exothermic chemical reaction when heated to a temperature sufficient to start said reaction, said holder comprising a flat relatively rigid disc of material of high heat conductivity adapted to be heated by eddy currents when surrounded by an alternating electric field, and means for holding said pellet against a face of said disc to be heated by heat conduction from said disc, said means consisting of an elastic metallic gauze element flexed and welded to said disc at a plurality of points near the periphery thereof and pressing said pellet firmly against said rigid disc.

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