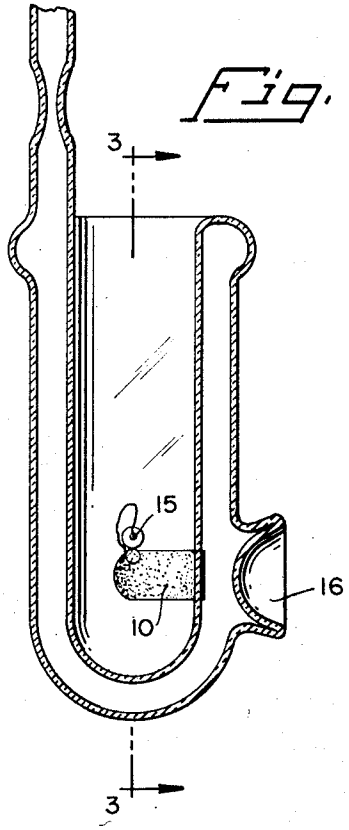
Aug. 12, 1958 L. E. SCHILBERG ET AL 2,847,329

SENSITIZATION OF PHOTOCONDUCTIVE CELLS
BY THE USE OF INDIUM VAPOR
Filed Feb. 15, 1957

Fig. 1.



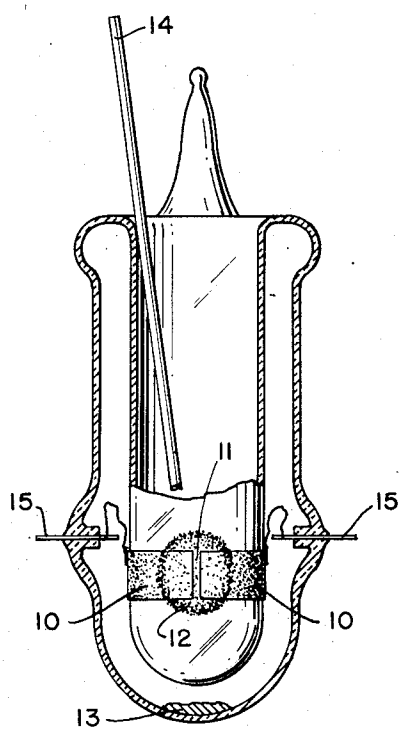


Fig. 2.

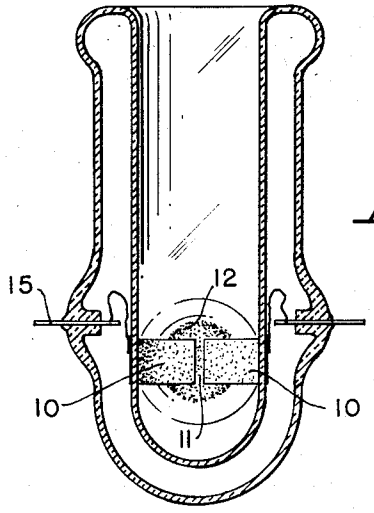


Fig. 3.

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United States Patent Office 2,847,329
Patented Aug. 12, 1958

2,847,329

SENSITIZATION OF PHOTOCONDUCTIVE CELLS BY THE USE OF INDIUM VAPOR

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Application February 15, 1957, Serial No. 640,563

1 Claim. (Cl. 117—211)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a process for making photoconductive cells of the bimetallic type, more particularly, it relates to a process for making photoconductive cells of increased sensitivity by vaporization techniques.

The photoconductive bimetallic element of photoconductive tubes is ordinarily deposited between the terminals of the cell by vaporizing the metal in an evacuated glass Dewar type cell and condensing it on the area between the terminals by cooling the area. In order to increase the photoconductance, or change the spectral range of maximum sensitivity of the photoconductive element, it has been the practice to add very small quantities of other elements to the original melt, a process known as doping. The resulting doped materials may show a large increase of impurity carriers and smaller activation energies than the original bimetal. While these methods increase the photoconductive sensitivity of bimetallic elements to some extent they do not increase it sufficiently for all purposes. This is particularly true in the case of cadmium telluride elements.

It is therefore an object of this invention to provide a process for making cadmium telluride photoconductive elements having greater sensitivity than those made by prior processes;

It is another object of this invention to provide a process as stated which is simple in application and provides reproducible results.

It has been found that the above objects are accomplished by the deposition of cadmium telluride in the presence of indium vapor.

The invention is best understood by reference to the following description taken in connection with the accompanying drawing hereby made a part of this specification, and in which:

Fig. 1 is a vertical cross-section of the photoconductive tube made by the process of the invention;

Fig. 2 is a vertical cross-section of the tube taken on a plane at 90° to the plane on which Fig. 1 is taken; and

Fig. 3 is a vertical cross-section taken on the line 3, 3 of Fig. 1.

Referring to Figs. 1 and 2, there is shown a conventional double-walled glass tube of the Dewar type used for photoconductive cells. A strip of "Aquadag" coating **10** or other suitable conductive coating is coated on the outer surface of the inner tube as shown, leaving a gap **11** between the terminals formed by the ends of the coating. "Aquadag" is essentially a water suspension of carbon. Another suitable coating is silver paint. The ends of the coating are referred to herein as the terminals of the conducting coating. The gap **11** is coated with cadmium telluride to form the photosensitive element **12**. At **13** is shown a small amount of the material, cadmium telluride, which is vaporized and the vapor condensed to form the photoconductive element **12** across the gap **11** between the terminals made by the broken strip **10**. A small amount of indium has been added to the cadmium telluride in the bottom of the tube to produce indium vapor. A glass tube **14** is used for introducing cool air into the Dewar tube to cool the surface of the gap during the deposition of the element **12**. Terminals **15** are provided for passing current through the cell. The Dewar tube is provided with a window **16** directly opposite the photoconductive element **12**. Fig. 3 shows the arrangement of the photoconductive element as seen from the interior of the tube.

In application of the process of the invention, pure cadmium telluride was made by combining purified cadmium and tellurium in stoichiometric proportions in a separate evacuated tube. A small amount of the formed cadmium telluride and a small amount of metallic indium were then placed in the bottom of the Dewar tube at **13**. The tube was heated to vaporize the cadmium telluride and indium and the cadmium telluride element **12** was deposited by condensation in the presence of indium vapor. It was necessary to raise the temperature to between about 580° C. and 640° C. to give sufficient indium vapor for the sensitization to take place. During the step of vaporization of the material **13**, cadmium telluride and indium, the area in the gap **11** between the terminals **10** was cooled by cool air introduced through the glass tube **14**. Following deposition of the photoconductive element, the tube was cooled and tested using a standard light source of about 2 foot candle power and a megohmmeter connected to measure resistance across the tube.

A large number of tubes were prepared by the above outlined process and tested for dark resistance and light resistance using a standard light source of about 2 foot candle power illumination. The table below shows the results obtained on five tubes, two of which, tubes **129** and **131**, had elements of pure cadmium telluride and three of which, tubes **128**, **130** and **132**, had elements of cadmium telluride applied in the presence of indium vapor. Measurements were taken at three temperatures, room temperature (298° K.), Dry Ice temperature (194° K.) and liquid nitrogen temperature (81° K.). The ratio of the dark resistance to the light resistance is shown for each tube. It will be noted that no dark resistance value is given for tubes **129** and **131** at liquid nitrogen

Tube No.	Material	Room Temp., 298° K.		Dry Ice Temp., 194° K.		Liquid Nitrogen Temp., 81° K.	
		Megohms (dark) Megohms (2 f. c.)	Ratio	Megohms (dark) Megohms (2 f. c.)	Ratio	Megohms (dark) Megohms (2 f. c.)	Ratio
128	CdTe In sensitized	30/0.5	60	40,000/5	8,000	5,000/0.26	20,000
129	CdTe	170/53	3	700,000/5,000	140	-/15,000	
130	CdTe In sensitized	20/0.7	30	20,000/1.2	17,000	20,000/0.26	800,000
131 [1]	CdTe (Sb)	34/8	4	50,000/500	100	-/2,200	
132 [1]	CdTe (Sb) In sensitized.	4.9/0.6	8	250/0.9	280	250/0.2	12,000

[1] These two samples of CdTe contained a trace of antimony.

temperature of 81° K. The dark resistances of these tubes at this temperature was too high to permit measurement with the equipment available. When indium was used for doping the cadmium telluride element in accordance to the prior art procedure, no appreciable increase in sensitivity was noted.

Using the ratio of the dark resistance to the resistance under an illumination of two foot candles as a measure of the sensitivity, it will be seen that in each case the indium vapor sensitized tubes have a higher sensitivity. This is still more marked in tubes cooled with Dry Ice and which are at a temperature of 194° K. The tendency is still seen in the data taken at liquid nitrogen temperature even though the comparison cannot be made, as the dark resistances of the tubes processed without indium are too high to be measured accurately with available equipment. It will be noted from examples 131 and 132 that the invention is also effective to increase the sensitivity of antimony doped cadmium telluride elements.

From the above results it is readily seen that a process has been provided for increasing the sensitivity of cadmium telluride photoconductive elements by a factor up to 20 at room temperatures, and up to 120 at 194° K., with a still greater increase in sensitivity indicated at a temperature of 81° K.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

A process for making photoconductive elements which consists in simultaneously evaporating cadmium telluride and indium at a temperature between about 580° C. to about 640° C. onto a surface in a vacuum.

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