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O. T. McILVAINE
METHOD OF MAKING PHOTOCELLS

2,809,134

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Fig. 1.

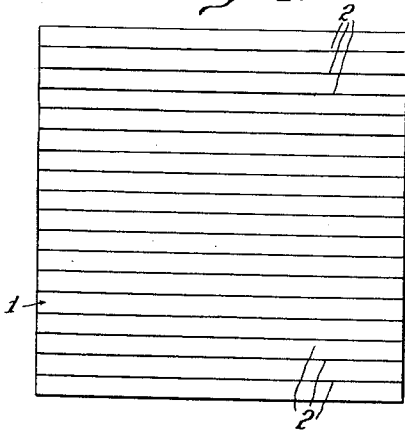


Fig. 2.

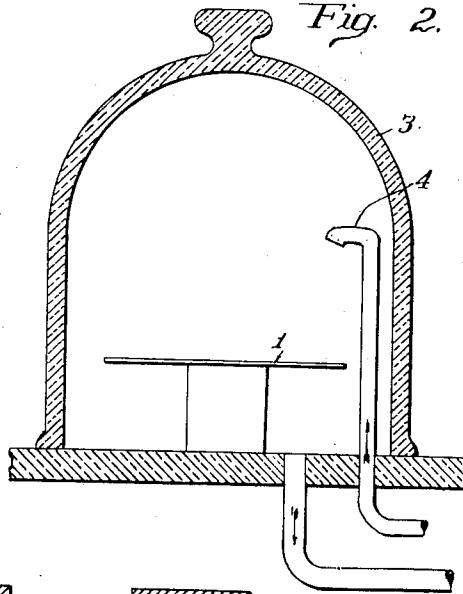


Fig. 3.

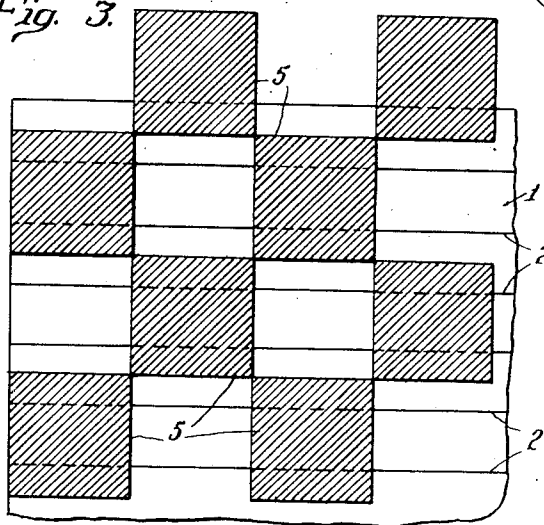


Fig. 5

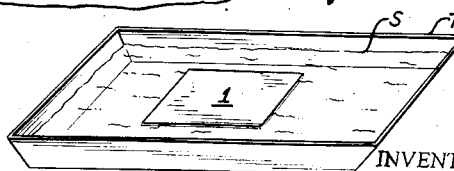
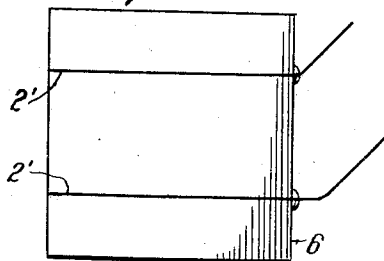


Fig. 4.



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METHOD OF MAKING PHOTOCELLS

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Application June 18, 1953, Ser. al No. 362,450

4 Claims. (Cl. 117—215)

This application is a continuation-in-part of my prior application for Photocells, Serial No. 275,435, filed March 7, 1952, now Patent No. 2,654,819, granted October 6, 1953.

This invention relates to improvements in photocells and more particularly to photo-sensitive or photo-conductive cells.

In making such cells heretofore it has been necessary to paint or draw on a base surface lines of silver, platinum, or other metal, before activation by lead sulfide or other semiconductors. Such operations in preparing the cells are slow and tedious, and require relatively large areas for producing the elements of the cell.

An object of this invention is to improve the process of making photocells of this character, to expedite the manufacture thereof, and to produce cells of relatively minute size.

A further object of the invention is to provide photo-conductive cells of the minute size which can be used in many installations where such cells have not been available for use heretofore.

These objects can be accomplished by applying the lines of conducting material onto a base surface, such as a flat surface, in close relation to each other. These lines may be applied chemically which enables the lines to be in close side-by-side relation, and to be relatively fine lines, much more compactly arranged than would be possible where they are painted or drawn by hand. Then, after sensitizing the lines by evaporating the semiconductive metal, such as lead sulfide, germanium or the like thereon, the base surface can be cut to form a multiplicity of minute photocells.

The semiconductor coating can be covered, if desired, with a transparent or other covering material such as varnish, plastic, etc., to protect the same during the treating operation and preparation of the individual cells.

The invention is illustrated in the accompanying drawings in which:

Fig. 1 shows the base material having lines applied thereto;

Fig. 2 shows diagrammatically the activation and protection of the base;

Fig. 3 shows the step of cutting out the individual cells by a stamping or punching operation;

Fig. 4 is a plan view of a completed cell thus formed;

Fig. 5 is a perspective view of a treating tray or vat.

Referring to Fig. 1, I have shown a base surface which can be either flat or curved, as desired, and may be made of any suitable insulating material, preferably a thin sheet 1. It is possible to use glass, mica, or other substances suitable for the purpose, which should have a surface capable of receiving the lines to be applied thereto in close relation, but may be either smooth or ground.

A series of lines, generally designated at 2, are applied to the surface 1 of a suitable conducting material, such as silver, platinum, tungsten, graphite, or the like.

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After thus forming the lines on the base 1 by ruling or otherwise, a semiconductor may be deposited thereover. Any of the known or usual materials for this purpose may be employed, such as lead sulfide, thorium, silicon, germanium, etc. Such a semiconductor can be deposited chemically, as by placing the sheet 1 or formed element in a tray or vat T in which it is subjected to a chemical treatment. If the treatment is to be applied in a tray, as indicated generally at T in Fig. 5, the solution is first put in the tray and then the sheet 1 to be covered is suspended in the solution, so that just the bottom side of the sheet is in contact with the solution. This will give a coating free from any sediment or any particles that will settle out. If coated in a tank, two sheets can be coated at one time by placing them back-to-back and suspending them on the edge in the tank. This would also prevent any sediment from collecting on the plates.

The solution for lead sulfide can be made in the following manner: A lead salt, such as lead acetate, is mixed with distilled water to give a dilute solution. Then a soluble salt, containing sulfur and oxygen, such as potassium thiosulphate or other similar salt, is mixed to give a dilute solution. These two solutions are then mixed in proportions of one part of the latter to four parts of the former solution. After thus mixing the solutions, they are placed in a tray to which one part of potassium hydroxide is added, being stirred in, and the plate or plates to be coated is then placed in the tray at once in the manner described. These proportions may be changed somewhat to vary the results obtained, as desired.

As an example, 5 cc. of a lead salt may be mixed with 20 cc. of thiosulphide, to which is added 5 cc. of potassium hydroxide. This will be enough solution to cover from four to six square inches.

The deposit will start to form at once and will continue for an hour or more, depending upon the variation of the parts added. The rate of deposit will determine the type of coating formed. Any type of coating, from a mirror-like surface to a dull gray or granular deposit can be formed by changing the concentrations somewhat. This in turn controls the light response given by the coating. By adding trace elements to the solution during the deposition, a substantial control can be had of the photo-electric response.

This photo-electric response can be controlled also to a substantial extent by heat treating the coating after forming and drying. As an example, baking in an oxygen atmosphere will give sensitivity, and other methods well known in the art can also be used for varying effects.

In some cases, after the plate has been coated chemically, it may be dried and placed in a vacuum chamber for further processing. Here it can be treated with oxygen under elevated temperatures and reduced pressures to procure the desired photo response. An example thereof is illustrated in Fig. 2, in which the vacuum chamber is designated at 3 and the source of oxygen may be admitted thereto, as indicated at 4.

Thereafter it is preferred to coat the surface with a suitable protective material such as transparent, translucent or opaque insulating material, such as varnish, resin or plastic, which may be applied by dipping or otherwise. This coating material will cover the surface of the semiconductor material on the base 1 and protect the latter in the subsequent operations without interfering with its effectiveness in use.

Thereafter, the chamber 3 is opened and the base 1, if made in multiple size, is cut up into individual cell elements. This may be accomplished by an assembly of punch or die elements, generally indicated at 5 in Fig. 3, which will sever the base 1 into a multiplicity of minute

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elements. The punch or die elements 5 should be so disposed as to cross a pair of adjacent metal conductor lines, as indicated in Fig. 3, preferably slitting the base midway between a pair of said lines 2. This produces a segment of the base, having a pair of conductor lines 2 extending across the same, as indicated at 2' in Fig. 4, where the individual cell element is designated generally at 6, which results from the stamping out of the treated base in the manner described. This stamping process preferably cuts the base into equal sized cells, a multiplicity of which may be formed from a single sheet, in the manner described, although these may be either square, rectangular, or of any other shape.

A portion of the covering material, such as plastic or varnish, may be stripped off at the ends of the conductor lines 2' to provide for electrical connections therewith, or the entire covering material may be removed, especially if the cell is to be used in vacuum.

The semiconductors described above may be used either single or combined in proper proportions to produce the spectral response desired. They may be mixed together in the solution, as will be evident to any one familiar with the art.

The process may be carried out with a thin sheet of mica, glass, or the like. If the sheet is formed of mica, it can be cut with dies, as described above; or if formed of glass, the back of the sheet can be ruled with a diamond cutter so that each individual cell can be broken off readily.

The cells can also be prepared in units before having the cutter applied thereto, and these individual units can be attached to a large sheet for processing in the manner described by depositing the semiconductor coating thereon and preferably also a protective coating thereover of plastic or other suitable material. The latter can be applied to the sheet or to the individual elements and may be transparent, translucent, or opaque. The coating material will protect the sensitized elements from moisture, handling and other outside influences which might affect the operation thereof.

It is possible to produce in this way very simply and inexpensively a multiplicity of minute photocells without the slow and laborious method of drawing or painting the conductor lines on the base surface and, at the same time, cells of very much smaller size can be used due to the small area required where the lines are applied in the manner described, especially by printing or photo-engraving the lines on the base surface.

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While the invention has been illustrated and described in certain embodiments, it is recognized that variations and changes may be made therein without departing from the invention as defined in the claims.

I claim:

1. A method of making a photocell comprising applying a plurality of lines of conducting material onto an insulating base surface, and applying a solution of a semiconductor thereover to sensitize said surface, said solution being formed by mixing a solution of a lead salt in water with a second solution of a soluble salt containing sulfur and oxygen.

2. A method of making a photocell comprising applying a plurality of lines of conducting material onto an insulating base surface, applying a solution of a semiconductor thereover to sensitize said surface, said solution being formed by mixing a solution of a lead salt in water with a second solution of a soluble salt containing sulfur and oxygen, and dipping the coated surface of the base in said solution.

3. A method of making a photocell comprising applying a plurality of lines of conducting material onto an insulating base surface, applying a solution of a semiconductor thereover to sensitize said surface, said solution being formed by mixing a solution of a lead salt in water with a second solution of a soluble salt containing sulfur and oxygen, and thereafter coating the base surface with a protective film.

4. A method of making a photocell comprising applying a plurality of lines of conducting material onto an insulating base surface, and applying a solution of a semiconductor thereover to sensitize said surface, said solution being formed by mixing a solution of a semiconductor selected from the class consisting of lead sulfide and germanium, with a second solution of a soluble salt containing sulfur and oxygen.

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