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A. H. LAMB

2,305,576

MULTIPLE UNIT PHOTOCELL

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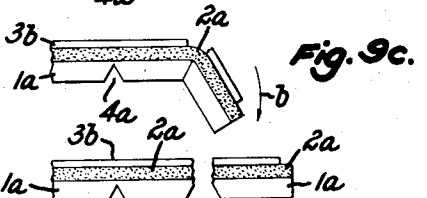
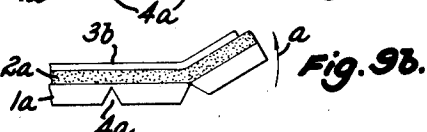
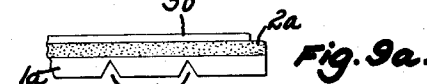
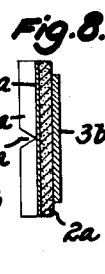
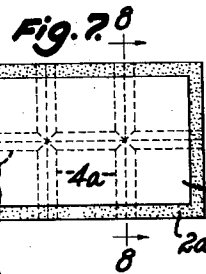
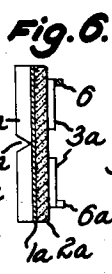
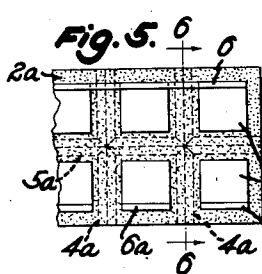
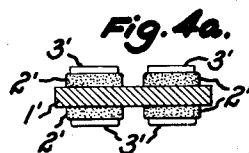
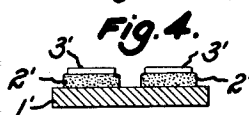
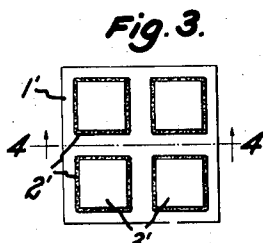
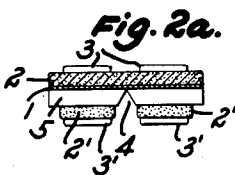
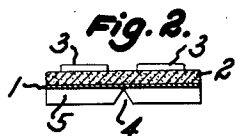
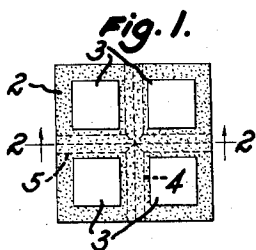


Fig. 9d. Anthony H. Lamb,

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UNITED STATES PATENT OFFICE

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MULTIPLE UNIT PHOTOCELL

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16 Claims. (Cl. 136—89)

This invention relates to the manufacture of photoelectric cells and more particularly, to the novel construction of dry disc type photocells of relatively small surface area.

Dry disc photocells are well known in the art and the preferred form comprises an iron base plate carrying a thin layer of selenium which, by various processes, is transformed into a metallic or conducting state. An exceedingly thin, translucent layer of metal is then sputtered over the selenium surface to form the upper or minus electrode, the other electrode being constituted by the iron base plate. Photocells of this type are used in many commercial applications, but the present art of manufacturing the cells is not sufficiently flexible to provide cells corresponding to the optimum size and shape required in particular applications. Certain applications require, by their very nature, photocells of very small area. Other applications require a plurality of relatively small cells to produce a differential effect related to a variable condition. Suitable amplifying means are employed to translate the feeble electrical effect of the photocells into forces of sufficient magnitude to produce useful results.

The present methods of manufacturing selenium photocells present a paradoxical situation in that it is more economical to make a relatively large photocell than a small one. Thus a photocell having an area of one square inch costs no more to produce than one having an area of one-tenth square inch. For this reason, users who require small photocells are compelled to cut up large cells into a plurality of smaller units. This may be done by sawing or punching, but in either case it involves a sizable expenditure of time and money. Further, during the separating process, the thin, upper electrode metal is forcibly displaced and almost invariably touches the iron base plate, thereby resulting in a short circuited cell. By carefully scraping along or digging into the sheared edges, under close examination, the short circuited condition may be corrected in some of the units, but a relatively large percentage of the severed units cannot be restored to a useful state and must be discarded. There is no certainty that the small cells, so corrected, will remain in operative condition and experience has proven that many of such cells become inoperative in a short time.

An object of this invention is the provision of a photocell of novel construction which may readily be subdivided into a plurality of smaller units without waste and at minimum cost. Another object is the provision of a dry disc photocell having a plurality of isolated photosensitized areas, each of said areas constituting a separate photocell. Another object is the provision of a multiple photocell comprising a plurality of sepa-

rate photocells formed on a common base. Another object is the provision of a multiple photocell comprising a base plate having a layer of selenium on each side thereof, and isolated photosensitized areas formed on each of the selenium surfaces.

Still another object is the provision of a photocell comprising a base plate having a substantially uniform layer of selenium thereon, a plurality of isolated photosensitized areas formed on the selenium surface, and a current collector overlying a portion of each photosensitized area, whereby the photocell may be physically divided into a plurality of individual photocells corresponding to the number of such areas, each of the individual photocells including a section of the current collector. Another object is the provision of a photocell having preformed grooves in the base plate, the grooves reducing the strength of the base plate to such low value that the photocell may be readily divided, by breaking, into a plurality of separate photocells. A further object is the provision of a photocell having grooves in the base plate whereby the photocell may be broken into a plurality of separate photocells by hand.

Further objects are to provide methods for the manufacture of photocells of relatively large size that may be separated into a plurality of smaller photocells without exposing the photocells to the possibility of becoming short circuited during the separating operation.

These and other objects and advantages will be apparent from the following description when taken with the accompanying drawing. The drawing is for the purpose of illustration and is not to be construed as defining the scope of this invention, reference being had for this purpose, to the appended claims.

In the drawing wherein like numerals refer to like parts in the several views:

Fig. 1 is a plan view of a relatively large photocell embodying the invention and having a base electrode grooved to facilitate separation into smaller photocell units;

Fig. 2 is a transverse section, on line 2—2 of Fig. 1;

Fig. 2a is a similar transverse section illustrating a modification that includes multiple photocell units on both sides of the base plate;

Fig. 3 is a plan view of a multiple photocell having isolated photosensitized areas;

Fig. 4 is a transverse section on line 4—4 of Fig. 3;

Fig. 4a is a similar transverse section illustrating a modification that includes isolated photocell areas on both sides of the base plate;

Fig. 5 is a fragmentary plan view of an elongated photocell having a plurality of isolated

counter electrode areas that each have a sprayed-on current collector spot or strip;

Fig. 6 is a transverse section through the same on line 6—6 of Fig. 5;

Fig. 7 is a fragmentary plan view of a large size photocell having continuous selenium and counter electrode layers on a grooved base plate;

Fig. 8 is a transverse section on line 8—8 of Fig. 7; and

Figs. 9a to 9d are a series of fragmentary side elevations illustrating successive steps in the separation of small photocell units from a large photocell such as shown in Figs. 7 and 8.

It is to be understood that the several transverse sections are not to scale as the counter electrode layer is transparent and exceedingly thin, being of the order of a single molecular layer of metal sputtered upon the selenium or other light sensitive material. The light sensitive layer is also thin, in comparison with the thickness of the back plate, and it is not possible to illustrate the several layers to scale in a view of practical dimensions.

As shown in Figs. 1 and 2, one face of the iron base plate 1 carries a light sensitive layer 2 that, in the case of selenium, has a thickness of only 0.003 to 0.005 inch. The selenium layer is applied and is transformed into a photosensitive state by processes well known in the art. Isolated areas of the selenium layer are provided with sputtered metallic coatings 3 that form counter electrodes, and the base plate 1 is provided with intersecting grooves 4, 5 that are located beneath the interspaces between the counter electrode areas 3.

Four photocell units are included in the embodiment shown in Figs. 1 and 2, and this multiple unit construction is adapted for separation into a plurality of small units or for use in bridge or bucking circuits to indicate or control a balanced condition. The base plate 1 forms the common plus electrode for the several units when the illustrated assembly is employed in a bridge or other multiple photocell circuit, and the spaced electrode layer sections 3 form the minus electrodes of the several photocells. For practical purposes, it may be considered that the photoelectric effect becomes manifest only at the coating surface between selenium layer 2 and the upper electrode, and therefore only the selenium sections that are covered by the upper electrode metal 3 form the photosensitive areas of the assembly. For use in separate circuits or to permit a spacing of the photocells of a multiple photocell circuit, the assembly may be readily broken into separate units or pairs of units by bending the base back and forth along the groove lines. The base plate 1 fractures along the groove, and the selenium layer is so thin that it parts readily, upon the breaking of the base plate, without establishing stresses that destroy or damage the close adhesion of the selenium layer to the base plate. Obviously, therefore, no stress is imposed upon the thin electrode layer 3 and there is no possibility of short-circuiting or otherwise damaging the separated photocell units.

It is frequently convenient in photometric and other light comparison operations to mount two photocells back-to-back. Multiple photocells for such uses may be formed upon a single base plate, as shown in Fig. 2a, by applying spaced areas 2' of selenium upon the grooved back of the base plate 1, and sputtering electrode layer 3' upon each selenium area. Suitably apertured masks are of course employed in forming the spaced selenium and collecting electrode layers.

The multiple photocell unit shown in Figs. 3 and 4 includes isolated areas 2' of selenium upon one face of an iron base plate 1', and collecting electrode layers 3' that are sputtered upon the several selenium sections. This type of photocell unit may also be used in a double faced assembly, as shown in Fig. 4a, in which pairs of selenium areas 2' are transversely aligned at opposite faces of the base plate 1'. Assemblies of this type can be separated into individual units or groups of units by cutting across one or both faces of the base electrode with a milling cutter or engraving tool to establish lines of fracture along which the assembly may be parted by bending. The previously employed methods of sawing, punching or shearing unit sections from a multiple cell assembly set up vibrations and stresses that tend to loosen the selenium layer from the base plate, and thus result in damage to some or all of the separated photocell units.

Multiple unit photocells such as described above may be formed upon a rectangular strip or an elongated band of iron that is grooved at its lower face to facilitate the separation of the photocell units, either individually or in groups, by bending operations. A mask may be used to provide spaced selenium areas of the type illustrated in Figs. 3 and 4, or, as shown in Figs. 5 and 6, a continuous layer 2a of selenium may be applied to the upper surface of an elongated iron base member 1a, and a mask may then be used to sputter spaced electrode areas 3a upon the selenium layer. The lower face of the base strip 1a is provided with deep transverse grooves 4a, 5a that lie beneath the interspaces between the electrode areas 3a. A strip of soft metal may be sprayed upon a portion of each counter electrode 3a to form a current collector or terminal for establishing electrical connections to an external circuit. The soft metal may be applied as a long strip 6 that extends over several electrode areas 3a and the interspaces between those areas, as is shown at the top of Fig. 5 or, alternatively, the cell assembly may be masked to limit the deposition of the soft metal to the narrow strip 6a individual to and the full width of the several counter electrode areas 3a, as is shown at the lower part of Fig. 5. These current collectors are in good electrical contact with the thin electrode layers due to their formation by a metal spraying operation, and they are substantially stronger than the thin electrode layers 3a and protect the latter against damage from the external terminal members.

As illustrated in Figs. 7 and 8, a continuous layer 2a of selenium and superposed continuous layer 3b of electrode metal may be applied to the upper surface of an elongated iron base strip 1a that has intersecting sets of grooves 4a, 5a cut into its lower face. A multiple photocell unit of this type may be broken into photocell units of any desired size by bending the base strip 1a at the selected grooves of the base plate.

The successive steps in the separation of a large photocell into smaller units are shown schematically in Figs. 9a to 9d with reference to a large photocell such as shown in Figs. 7 and 8. The location of the grooves or partition lines of the base plate corresponds of course to the desired size and shape of the smaller units that are to be formed. The grooves or partition lines may be cut into the base plate after the photosensitive layers are formed on the base plate but are preferably formed in the base plate blank before any coatings are applied. The outer section of the

assembly is bent upwardly manually, as indicated by arrow *a* of Fig. 9b, thereby completely severing the base plate at the groove 4a. The outer section is then bent downwardly, as indicated by arrow *b* of Fig. 9c, thereby completely severing the upper electrode 3b in line with the subjacent groove 4a. Thus the two rigid, hard metallic layers, i. e. the base plate 1a and the upper electrode 3b are severed without the possibility of touching each other to short circuit the unit. The selenium layer 2a is relatively soft and pliable, and hence remains intact throughout the stated bending operations. To complete the separation, the outer section is merely pulled away from the assembly to break the selenium layer, as shown in Fig. 9d.

The customary coating of a transparent moisture proof varnish may be applied to the photocell either before or after, or both before and after, the subdivision of a multiple unit assembly into smaller sections.

The grooves are preferably V-shaped and formed by a milling operation, but the grooves may be formed by other machine tools when the base plate blank is grooved before the selenium coating is applied. The lines of weakness can also be formed by shearing partially through the base electrode blank, or by punching out a series of holes, when both the selenium layer and the outer electrode layer are to be applied as isolated sections, as in Figs. 3 and 4.

The invention has been described with reference to photocells in which selenium is employed as the photosensitive material but it will be apparent that the invention can be applied to the subdivision of photocells that include cuprous oxide, tellurium or other photosensitive materials.

It is to be understood that the invention is not restricted to the particular embodiments herein shown and described, and that the above and other variations that may occur to those skilled in the art fall within the spirit of my invention as set forth in the following claims.

I claim:

1. The process of forming a multiple unit photocell assembly which comprises decreasing the bending and fracture resistance of the base electrode along preselected lines that extend between adjacent unit sections of the assembly, forming a layer of a light sensitive material upon each unit section of the base electrode, applying an adherent outer electrode layer to the photosensitive layer of each unit section, and bending the base electrode back and forth along a selected line of decreased fracture resistance to separate a photocell unit from the completed multiple unit photocell assembly.

2. The process as claimed in claim 1, wherein the light sensitive layer is applied to the base electrode as a continuous layer extending over a plurality of unit sections.

3. The process as claimed in claim 1, wherein the light sensitive layer is applied to the base electrode as a continuous layer extending over a plurality of unit sections, and the electrode layer is sputtered upon the light sensitive layer in isolated areas corresponding to the respective unit sections.

4. The process as claimed in claim 1, wherein the light sensitive layer is applied to the base electrode in isolated areas corresponding to the respective unit sections.

5. The process of forming a multiple unit

photocell assembly which comprises grooving one face of a base electrode to define a plurality of unit sections, applying a layer of a light sensitive material to the opposite face of the base electrode in each unit section, and sputtering an electrode layer upon the light sensitive layer of each unit section.

6. The process of forming a multiple unit photocell assembly as claimed in claim 5, wherein the light sensitive material is applied to the base electrode as a continuous layer extending over a plurality of unit sections.

7. The process of forming a multiple unit photocell assembly as claimed in claim 5, in combination with the steps of applying light sensitive material to the grooved face of said back electrode in isolated areas between and spaced from said grooves, and sputtering electrode layers upon said isolated areas of light sensitive material.

8. The process of forming a multiple unit photocell assembly as claimed in claim 5, in combination with the step of spraying a soft metal current collector upon a portion of the electrode layer of each unit section.

9. A multiple unit photocell assembly comprising a base electrode grooved at one face along preselected fracture lines that define a plurality of unit sections, a photosensitive layer on each unit section of said base electrode, and an electrode layer overlying the photosensitive layer of each unit section.

10. A multiple unit photocell assembly as claimed in claim 9, wherein said photosensitive layer extends continuously over a plurality of unit sections.

11. A multiple unit photocell assembly as claimed in claim 9, wherein said photosensitive layer extends continuously over a plurality of unit sections, and said electrode layer comprises an individual area for each unit section.

12. A multiple unit photocell assembly as claimed in claim 9, in combination with a current collector of soft metal sprayed upon a portion of the electrode layer of each unit section.

13. A multiple unit photocell assembly comprising a base electrode, a layer of photosensitive material on each face of the base electrode, and an electrode layer overlying each layer of photosensitive material.

14. A multiple unit photocell assembly comprising a base electrode grooved at one face at preselected fracture lines that define a plurality of unit sections, a layer of photosensitive material at the opposite face of said base electrode and extending over at least a part of each unit section, and an electrode layer overlying at least a part of the photosensitive material layer of each unit section.

15. A multiple unit photocell assembly as claimed in claim 14, in combination with spaced sections of photosensitive material carried by the grooved face of said base electrode between and spaced from the grooves thereof, and an electrode layer overlying each of said spaced sections of photosensitive material.

16. A multiple unit photocell assembly comprising a base electrode, a continuous layer of photosensitive material upon said base electrode, and four spaced sections of a transparent electrode layer sputtered upon said photosensitive material layer.

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