Feb. 2, 1954 C. F. TAYLOR ET AL 2,668,184

MULTIPLE PHOTOCELL STRUCTURE

Filed Feb. 15, 1952

2 Sheets-Sheet 1

Fig. 1.

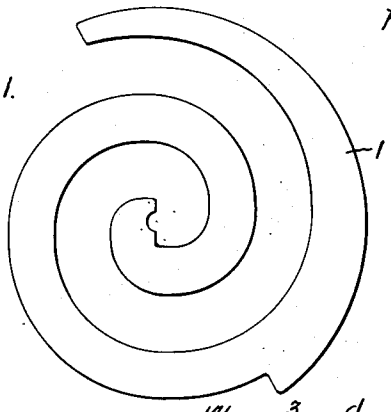
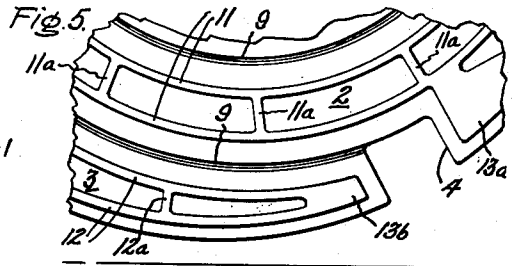


Fig. 5.



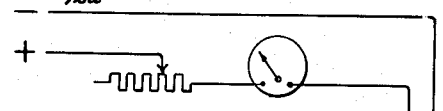


Fig. 2.

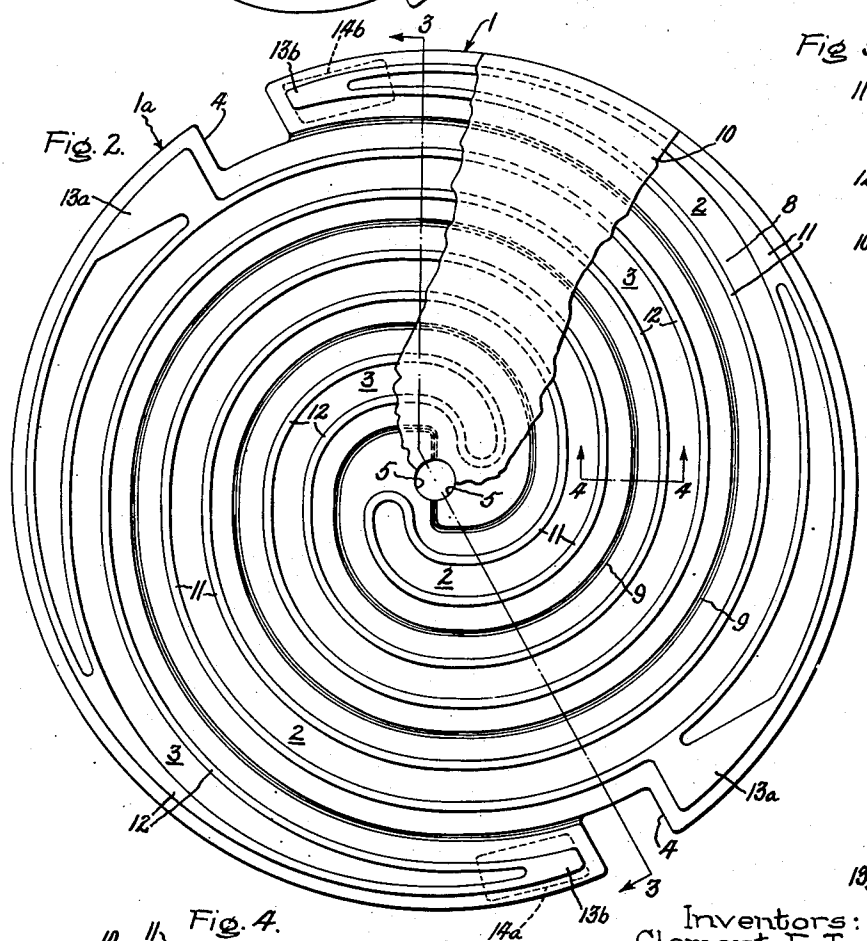


Fig. 3.

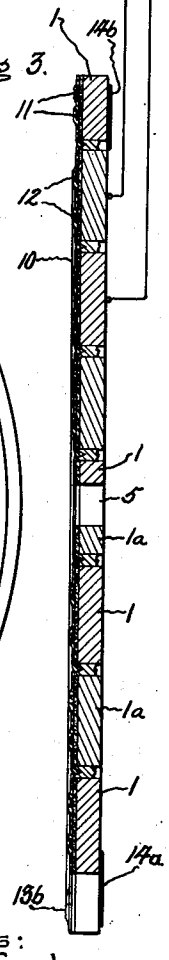
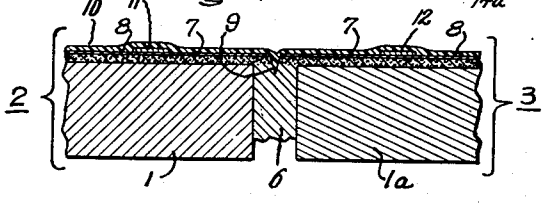


Fig. 4.



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Fig. 6.

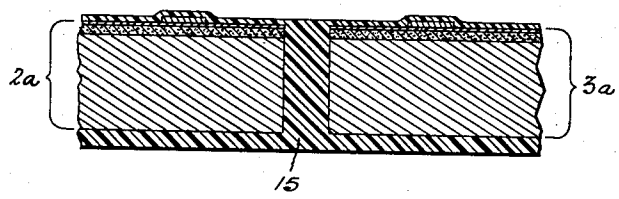
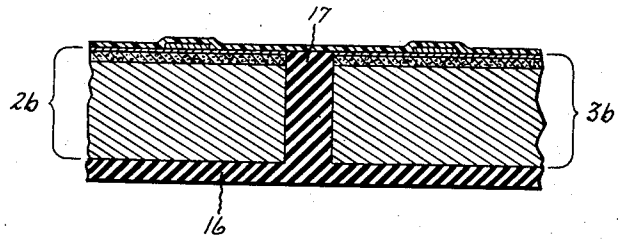


Fig. 7.



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MULTIPLE PHOTOCELL STRUCTURE

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Application February 15, 1952, Serial No. 271,746

17 Claims. (Cl. 136—89)

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This invention relates to a multiple photocell structure and its method of manufacture.

In the co-pending application of Allen G. Stimson, Clement F. Taylor and Hans A. Bakke, Serial No. 286,494, filed May 7, 1952, entitled "Photoelectric Measuring Instrument," assigned to the same assignee as the present application, there is described a color control meter which employs a pair of similar, spiral-shaped photocells which are "interleaved" or nested together, the convolutions of one cell occupying the spiral space between the turns of the other cell, with the sensitive surfaces of the cells lying in a common plane. These cells must be insulated from each other, and the present invention includes one method of manufacturing such composite photocells and the resulting structure. The invention is applicable generally to multiple photocell structures where two or more cells are fabricated into a unitary assembly with their light sensitive surfaces in a common plane and the cells insulated from each other.

An object of the invention is to provide a multiple photocell unit of the type described so arranged that the set of separate photocell elements comprising the unit will have a linear response characteristic in order that the reading of the color control meter will be independent of the intensity of the illumination.

A further object is to provide a multiple photocell structure capable of producing an output independent of the direction at which the illumination strikes the unit.

A still further object is to provide a multiple photocell unit specially adapted to cooperate with spiral masking means so as to obtain a long range of movement of the masks, as described more particularly in the copending application of Clement F. Taylor, Serial No. 275,414, filed March 7, 1952, entitled "Multiple Masked Photocell Structure," assigned to the same assignee as the present application.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings in which Figure 1 shows the plan shape of each spiral photocell element, Figure 2 is a plan view of two spiral photocell units in assembled relation, Figure 3 is a sectional view taken along the line 3—3 in Figure 2, Fig. 4 is an enlarged

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sectional view of a portion of the multiple photocell structure showing the nature of the junction between the cells which mechanically unites them into a single structure yet keeps them substantially insulated electrically, Figure 5 is a detail elevation showing one possible modification of the cell assembly of Figure 2, Figure 6 is an enlarged sectional view, somewhat similar to Figure 4, showing a modification, and Figure 7 is an enlarged sectional view showing another modification.

Features which are considered to be novel and patentable will be pointed out in the claims appended hereto.

In Figure 1 there is shown the plan form of the steel blank or "backplate" 1 for one of the spiral photocells. The plate 1 is so shaped and dimensioned that it may be interlinked or nested together with an identical plate, with the turns of one substantially filling the space between the turns of the other, as will be apparent in Fig. 2, where 2 and 3 represent two spiral photocells each having a backplate shaped as in Fig. 1. The backplates 1, 1a for the two cells are dimensioned so that when assembled as in Fig. 2, there is a gap of about 0.02 inch between the adjacent edges at all points. It will be evident that the two backplates, being identical, may be stamped with the same punch and die. Each spiral as here represented has approximately two complete turns and each has a "step" at 4 in its outer periphery located approximately 180° from its outer end, and is otherwise shaped so that, when the two spirals are interlinked, the complete structure will have a circular outline with notches at opposite points on the periphery between the step 4 in one cell and the outer end of the other cell. Such peripheral notches may be used to accommodate the connecting wires and terminal clips (not shown).

The inner ends of the matching spiral cells are shaped for abutting relationship, with a half circle cut-out (shown at 5) in each, so that a circular guide post (not shown) may be inserted therein during assembly to assist in obtaining uniform spacing between cell blanks.

The first step in the manufacture of the spiral cells, after the backplates are available, is to cover one surface of each plate with a thin coating of selenium, for example, and assemble the

coated blanks in the pattern they are to occupy in the finished structure on a flat surface or flat-bottomed tray with their selenium coatings in alignment in a common plane and with suitable guides, such as the sides of the tray, correctly positioning and supporting the outer convolutions of the spirals. As a matter of fact, the selenium coating may be applied either before or after the plates are assembled in interlinking relation. The assembled and coated parts are then subjected to pressure at right angles to their surface by a flat-surfaced press, the pressure being not less than 100 pounds per square inch and perhaps as high as 1000 pounds per square inch, and at a temperature of from 125 to 190 degrees C. The selenium softens and is pressed until the selenium coating on the flat surfaces of the plates is reduced to a thickness of between 0.003 and 0.005 inch, and the excess selenium completely fills the 0.02-inch gap between the spiral plates. The pressure and temperature used, the thickness of the selenium coating, and the gap dimension are not very critical, so long as the result is a uniform compact thickness of at least 0.003 inch of selenium on the upper surface and a complete filling of the gap between the plates with selenium. This firmly unites the two backplates with a single mechanical unit.

Any excess selenium on the outer circumferential edges of the backplates is then removed, and the selenium on the surface of the plates is converted to the light-sensitive crystalline form, as by baking in an oven at a temperature of about 218° C. for the proper length of time. For some uses and circuit arrangements, the selenium in the gap between the two backplates may be left in the crystallized state and it, therefore, forms a low resistance bond between the backplates of the cells. For other purposes and circuits, the crystallized selenium between the cells does not offer sufficient resistance, and in such cases it can be given a much higher resistance by converting the selenium in the gap from the crystalline to the amorphous form. Such conversion may be accomplished either before or after the exposed selenium surface coating is processed in the usual way for rendering the cell photo-sensitive; but we generally prefer to do it before. Hence, where the crystallized selenium between the cells is to be converted to the amorphous form to increase its resistance, as required in the color control meter of the above-identified application of Stimson and Bakke, we prefer to make this the next step. The thin layer of selenium on the top exposed surfaces of the cells must, however, remain in crystalline form.

The selenium in the gap between the plates may be changed from crystalline to amorphous form, without substantially altering the selenium in the surface layer, by passing an electric current between the backplates and across the gaps to heat the selenium in the gap above its melting point of about 220° C. If then the structure is quickly cooled, the selenium in the gaps will retain the amorphous form and will be of high resistance. The resistance between the backplates may be increased to about 50,000 ohms in this way.

The electrical connections for this step may be as represented diagrammatically in Fig. 3; and for the cell combination described herein, which had an outer diameter of about two inches, we found that passing a current of about 1½ amperes for 30 seconds between the cell plates was sufficient. More correctly, the current at the start of this 30 seconds is about 1½ amperes and decreases as the change takes place. This heating current does not tend to cross through the surface layer 7 of the selenium, which therefore remains well below its melting point and retains the crystalline form.

Another method of melting the selenium in the gaps is to pass an electrically heated wire through the gap from end to end, the wire being maintained at right angles to the plates like a "cheese cutter" and moved along as fast as the selenium in contact therewith melts. As soon as the hot wire has passed the melted selenium cools in the amorphous form and most of it is retained in the gaps to bond the plates together.

The next step in preparing the cells for use is to "sputter" the surface selenium 7 with a layer of a conductive material, such at platinum, etc., as described for example in United States Patent No. 2,296,670, issued September 22, 1942, and assigned to the same assignee as the present application. This conducting surface layer is applied over both cells but not on the outside edges, and must be cut through above the gap between the plates to electrically separate the two cells. A sharp instrument such as an engraving tool may be used for this purpose, and a cut between 0.001 and 0.01 inch deep is satisfactory.

Fig. 4 represents an enlarged cross section view of the cell combination, taken through one of the gaps and adjacent cell parts. The two spiral steel backplates or cell blanks are shown at 1, 1*a*, the two cells at 2, 3. The amorphous selenium in the gap between the cells is identified 6, the crystalline selenium surface layer at 7, the sputtered conductor layer 8, and 9 is the cut for separating the conductor layers of the two cells.

In order that all portions of the photo-sensitive selenium surface will have a low-resistance path to the terminals of the photocell unit, there is provided a rather complicated network of collector strips on the top surface of the conductive layer 8, which strips may be conveniently applied to the conductive layer 8 by spraying a metal, such as cadmium, with suitable masking arrangements. The shape of these collector strips is shown in Fig. 2, in which 11 is the spiral collector strip for cell 2 and 12 is the collector strip for cell 3. These collector strips are in the form of a double spiral dividing the spiral cell into three parallel strips of roughly equivalent area. Adjacent the outer ends of the spiral cells, these collector strips have three, instead of two, parallel paths so that all portions of the light sensitive area of the cells have direct access to the low resistance collector strip. It is also to be noted that these collector strips widen out adjacent the "step" 4 to form the terminal portions 13*a*, 13*b*. These terminals are adapted to be engaged by contact clips (not shown) connected to the lead wires for the external circuit. The back surface of the backing plates carries similar sprayed cadmium terminals identified in Fig. 2 in dotted lines at 14*a*, 14*b*.

Certain production difficulties have been traced to the fact that the cadmium collector strips 11, 12 may be imperfectly sprayed, so that there are "open-circuited" portions which increase the overall resistance of the cells. To provide low resistance paths around such open-circuited portions of the collector strips, there may be provided additional radial shunt strips connecting the two spiral strips, as shown in Fig. 5 at 12*a*

and 11a. These radially disposed bridging strips may, for instance, be spaced about ½ inch apart, measured along the spiral. Thus the photosensitive surface of each cell is covered by a complete network, the resistance of which will be substantially unaffected by any local discontinuities in the spiral collector strips.

A useful rule of thumb in designing the network of conductive collector strips 11, 11a, 12, 12a is that no portion of the photosensitive area of the cells shall be more than .100 inch from a collector strip. It may be found desirable to have a distance as small as about .050 inch from a collector strip to each portion of the photosensitive area. Of course it must be remembered that the collector strips mask a certain amount of the photosensitive area. Therefore, increasing the number of collector strips reduces the effective area of the photosensitive surface. Thus a balance must be struck between having a sufficient network of collector strips to avoid the adverse effect of any discontinuities in the strips, yet not covering so much area as to reduce the sensitivity of the cell. The suggested spacing of .050 to .100 inch from the collector strips to all portions of the photosensitive area, with the bridging strips 11a, 12a spaced about ½ inch apart, appears to effect a good compromise.

After the cadmium collector strips have been applied, the top surface of the photocell unit is protected by a coating of transparent lacquer 10 (Figs. 2 and 4).

The cell structure of our invention where the layer 6 between the cells is rendered amorphous, so as to have high resistance, may have the cells connected in series relation without any danger of short-circuiting a cell. This is possible because of the very high resistance between cells. In applications where the cells are to be connected in a differential circuit with the backplate terminals connected together, that is, with the cells in parallel, it is unnecessary to change the selenium layer 6 between the cells from the crystalline to the amorphous condition. In either case the method of manufacture by the application of heat and pressure to the selenium coating, which operation fills the space between the backplates under pressure provides a rugged, integral, multiple photocell structure where the separate cell structures are cemented together in a predetermined, precisely spaced relation as desired for obtaining accurate light component measurements.

A multiple photocell unit in accordance with the invention has the extremely important advantage of exposing the active photosensitive area of each cell at the same average distance from the light source regardless of the direction from which the illumination falls on the cell. This is extremely important in illumination color measurements for photographic purposes where many different types of light are encountered. Another important advantage is that a linear response characteristic is achieved when the two cells are connected in series, for measuring the ratio between two different components of the illumination, by reason of the special arrangement of the collector strip network, which provides substantially equal access for the photoelectric current from all parts of the photosensitive surface to the low resistance collector strips. Thus the resistance of the very thin conductive surface coating 8 does not affect the electrical characteristics of the cells. This is found very necessary if the measurement is to

be independent of the intensity of the illumination. The spiral configuration of the photocells adapts them for effective cooperation with the spiral mask system of the above-identified application Serial No. 275,414.

While only one form of the invention has been described specifically herein, it will be obvious to those skilled in the art that the arrangement may be applicable to multiple photocell units having three or more "interleaved" spiral cells. The precise shape of the cells, the pattern of the collector strips required to provide low resistance access to all portions of the photosensitive surface, and the arrangement of the terminal portions of the collector strips may obviously take many equivalent forms.

It will also be apparent that these complementary photocells may be made by other processes than that disclosed herein. For instance, as shown in Figure 6, a multiple photocell having the configuration shown in Fig. 2 could be made by fabricating a photosensitive disk, then sawing it into two spirals, 2a and 3a, and securing the two spirals in spaced relation to each other by embedding them in a suitable plastic cement 15 or other insulating bonding material. Such method of manufacture has the important advantage that any local non-uniformities in photosensitive activity would likely be common to both cells. In other words, any non-uniform area of substantial size would extend from one spiral across to a portion of the other spiral so that both cells would be affected. The first-described method of manufacturing the spiral cells, by fabricating separate backplates, coating them with selenium, and "sensitizing" the selenium coating on both cells at the same time, would share this advantage to some extent. Fabricating the backplates separately has the advantage of avoiding the complicated sawing operation required to divide a circular cell into two spirals.

Still another method of fabricating the multiple spiral photocell, illustrated in Figure 7, would be to secure the separate spirals 2b and 3b to a molded plastic backplate 16 having a spiral projection 17 on one face which serves to locate and space the spirals from each other.

It is of course desired to cover by the appended claims all such modifications as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A multiple photocell structure comprising two similar spiral-shaped photocells interlinked in a common plane so that spiral portions of one cell lie between spiral portions of the other cell and spaced from each other by gaps of approximately 0.2 inch filled with amorphous selenium which insulates the cells from each other and unites the cells into one mechanical structure, the outer ends of said spiral cells being shaped such that the outline of the complete structure is substantially circular.

2. A multiple photocell structure comprising a pair of similar spiral-shaped photocells, said cells being interlinked in a common plane such that spiral portions of one cell lie between spiral portions of the other cell, each cell having a metal backplate and a crystalline selenium coating conforming to the spiral shape of the cell, the interlinked adjacent surfaces of such backplates being separated from each other by a spacing of the order of 0.02 inch, and the gaps thus formed being filled with amorphous selenium which is continuous with the selenium surface coating

of the cells, said amorphous selenium insulating the cells from each other and uniting said cells into one solid mechanical structure.

3. A multiple photocell structure comprising a pair of similar spiral-shaped cells, said cells having spiral metal backplates interlinked with each other so that spiral portions of one lie between spiral portions of the other in the same plane and spaced apart by gaps of the order of 0.02 inch, the upper surfaces of said plates being coated with light sensitive crystalline selenium and the gaps between the plates being filled with selenium, the crystalline selenium on the light-sensitive surface and the selenium in the gaps being continuous and uniting said cells into a solid mechanical structure, terminals adjacent the outer spiral ends of said cells, and spiral-shaped conductor strips for the selenium coated surfaces of said cells leading from said terminals to adjacent the inner spiral end portions of said cells.

4. A multiple photocell structure comprising two separate spiral-shaped photocells having photosensitive surfaces disposed in a common plane, the convolutions of one cell lying in the spiral space defined between adjacent cell convolutions and spaced therefrom by a gap of substantially constant width along the spiral length of the cell, and means securing said cells in fixed relation to each other, the outer convolutions of the cells being shaped so the outline of the photocell assembly is generally circular.

5. A multiple photocell structure comprising a plurality of complementary spiral photocells interleaved with the convolutions of one cell lying in the spiral space defined between adjacent cell convolutions, the flat top surfaces of all cells lying in a common plane and having a coating of photosensitive material, adjacent convolutions being spaced from each other by a gap of substantially constant width along the spiral length of the cell, means securing the separate cells in fixed relation to each other, the outer convolutions of the spiral cells being modified so that the perimeter of the composite cell unit is of generally circular configuration.

6. A multiple photocell structure comprising at least two separate photocells with photosensitive surfaces disposed in a common plane, means securing said cells in fixed relation to each other, each cell having a transparent conductive coating on the photosensitive surface thereof and a network of narrow low resistance collector strips disposed in contact with said conductive coating, no portion of the photosensitive surface being more than .100 inch from the nearest collector strip portion.

7. A multiple photocell structure comprising at least two spiral cells of similar shape, each cell having a conductive backplate member coated on one surface with photosensitive material covered by a transparent layer of conductive material, the several cells being disposed in the same plane with the convolutions of one cell lying in the spiral space defined between the other cell convolutions with a gap of substantially constant width separating adjacent convolutions, means securing said backplates in fixed relation to one another, each cell having at least one narrow low resistance collector strip disposed in contact with said conductive layer and extending substantially the entire spiral length of the cell whereby the entire photosensitive surface thereof has a path of low electrical resistance to the external convolution thereof, the collector strip of each cell having at least one enlarged terminal portion of conductive material on the outer convolution thereof, whereby the relative electrical output of the cells is substantially independent of the intensity of illumination and of the direction at which light falls on the cell.

8. A multiple photocell structure comprising a plurality of spiral cells, each cell having a conductive backplate coated on one surface with photosensitive selenium covered by a transparent surface layer of conductive material, the several cells being disposed in the same plane with the convolutions of each cell lying in the spiral space defined between the other cell convolutions with a gap of substantially constant width separating adjacent convolutions, said gap being filled with plastic material bonding the backplates into an integral mechanical structure, each cell having at least two parallel low resistance collector strips disposed in contact with said conductive layer and extending substantially the entire length of the spiral, whereby the entire photosensitive surface of the cell has a path of low electrical resistance to the external convolution thereof, a collector strip of each cell having at least one enlarged terminal portion of conductive material, whereby the electrical output of the cells is substantially independent of intensity of illumination and of the direction at which light falls on the cell.

9. A multiple photocell structure in accordance with claim 8 and including radially disposed shunt collector strips connected across the parallel spiral collector strips at spaced intervals along the spiral length thereof, whereby all portions of the photosensitive surface have direct access to the low resistance network of collector strips.

10. A multiple photocell structure comprising at least two spiral cells of similar plan shape, each cell having a conductive backplate member coated on one surface with photosensitive crystalline selenium with a transparent surface layer of conductive material, the several cells being disposed in the same plane with the convolutions of one cell lying in the spiral space defined between the other cell convolutions with a gap of substantially constant width separating adjacent convolutions of the respective cells, said gap being filled with selenium continuous with the surface coating and bonding the backplates into an integral mechanical structure, each cell having at least one narrow low resistance collector strip disposed in contact with said conductive layer and extending substantially the entire length of the spiral whereby the entire photosensitive surface of the cell has a path of low electrical resistance to the external convolution thereof, the outer circumferential edge of each cell defining a circular arc so that when in interleaved relation the multiple cells have a generally circular outer configuration, said outer circular arc portion of each cell terminating at either end in a radially disposed step portion spaced circumferentially from a corresponding step portion of the adjacent cell to define a notch in the generally circular contour of the unit, each collector strip being connected to at least one enlarged terminal portion of conductive material disposed on the outer convolution of the cell adjacent one of said steps.

11. A multiple photocell structure comprising a plurality of complementary spiral photocells interleaved with the convolutions of one spiral cell lying in the space defined between adjacent

convolutions of the complementary cells, with the flat top surfaces of all cells lying in a common plane and adjacent convolutions spaced from each other by a gap of substantially constant width on the order of .02 inch, a layer of photosensitive selenium covering the flat top surface of the cells and filling the gaps between cells whereby they are bonded into an integral mechanical unit, the outer convolutions of the spiral cells being shaped so that the circumference of the composite cell unit is of generally circular configuration.

12. A multiple photocell structure comprising at least two spiral cells of similar shape, each cell having a conductive backplate member coated on one surface with photosensitive crystalline selenium covered by a transparent surface layer of conductive material, the several cells being disposed in the same plane with the convolutions of one cell lying in the spiral space defined between the other cell convolutions with a gap of substantially constant width separating adjacent convolutions, said gap being filled with selenium continuous with the surface coating and bonding the backplates into an integral mechanical structure, each cell having at least one narrow low resistance collector strip disposed in contact with said conductive layer and extending substantially the entire length of the spiral whereby the entire photosensive surface of the cell has a path of low electrical resistance to the external convolution thereof, the collector strip of each cell having at least one enlarged terminal portion of conductive material disposed on the outer convolution thereof, whereby the relative electrical output of the cells is substantially independent of intensity of illumination and of the direction at which light falls on the cell.

13. The method of constructing a multiple photoelectric cell unitary structure which consists in taking a plurality of metal backing plates of the same thickness and of the size and shape of the cells to be formed, covering one flat surface of such plates with a thin layer of selenium, assembling such plates on a flat surface in the relative positions which they are to occupy in the finished structure and with a spacing between the plates on the order of 0.02 inch, applying pressure at right angles to the flat surface of the plates while the plates and selenium coatings thereon are at a temperature between 125 and 190 degrees C. and thereby compressing the selenium coatings to a thinner uniform thickness and forcing excess selenium into the space between the plates completely to fill the same and unite the selenium covered plates into a solid mechanical structure, treating the selenium surface of such structure to convert the same for photoelectric cell use and then cutting into only the treated surface above the selenium filled spaces between the plates to form electrically separated photocell surfaces conforming to the pattern of the plates.

14. The method of constructing a multiple photoelectric cell unitary structure which consists in taking a plurality of metal backing plates of the same thickness and of a size and shape of the cells to be formed, covering one flat surface thereof with a thin layer of selenium, assembling such plates on a flat surface in the pattern of the cells to be formed and with a spacing of at least 0.02 inch between the plates, applying pressure at right angles to the surface of the plates while the plates and selenium coating thereon are at a temperature between 125 and 190 degrees C., the pressure being sufficient to reduce the coatings to a thinner uniform thickness of not less than 0.003 inch and to squeeze excess selenium into and completely filling the space between the plates, treating said structure to change the selenium to crystalline form, then converting only the selenium in the space between the plates to amorphous form, providing a thin conductive coating over the crystalline selenium surface, and then cutting through such coating over the selenium filled gaps between the plates to provide electrically insulated but mechanically united photocells.

15. The method of constructing a multiple photocell unit which consists in forming a plurality of conductive backplates of complementary plan shapes such that they may be disposed in interleaved relation with gaps of substantially constant width therebetween, covering one flat surface of the backplates with a thin layer of selenium, assembling the plates on a flat surface in adjacent relation with gaps of substantially constant width therebetween, applying pressure to the selenium at an elevated temperature sufficient to reduce the selenium surface coating to a thin uniform thickness and to force excess selenium into the gap between backplates whereby the plates are mechanically bonded together, converting the selenium to light-sensitive crystalline form, converting the selenium in the gaps between plates to high-resistance amorphous form by melting only the selenium in the gaps and then cooling it rapidly, applying a transparent conductive coating over the crystalline selenium surface, and making an incision extending entirely through the crystalline selenium surface layer, said incision lying over and extending the length of the gaps between plates to electrically insulate one cell from the other.

16. The method of constructing a multiple photoelectric cell unit which consists in forming a plurality of conductive backplates of such complementary shape that they can be disposed adjacent one another in interleaved relation with gaps of substantially constant width therebetween, covering one flat surface of the backplates with a thin layer of selenium, assembling the plates on a flat surface in interleaved manner with substantially constant gaps between cells, applying pressure to the selenium coatings with the plates and selenium at an elevated temperature to compress the selenium surface coating to a thin uniform thickness and force excess selenium into the gaps between backplates whereby the plates are integrally united, treating the surface coating of selenium to convert it to photosensitive crystalline condition, treating the selenium in the gaps to convert it to the amorphous condition, and electrically separating the cells by making an incision through the photosensitive surface coating, said incision lying above and extending at least to the amorphous selenium in the gap between the backplates.

17. The method of constructing a multiple photocell unit which consists in forming a plurality of conductive backplates of such complementary shapes that they can be disposed adjacent one another in interleaved relation with gaps of substantially constant width therebetween, covering one flat surface of the backplates with a layer of selenium, assembling the plates on a flat surface in interleaved relation with substantially constant gaps between plates, applying pressure to the selenium coating with the plates and selenium at an elevated temperature to compress

the selenium surface coating to a thin uniform thickness and force excess selenium into the gaps between plates whereby they are integrally united, treating the surface coating to convert it to photosensitive crystalline condition, treating the selenium in the gaps to convert it to amorphous condition, applying a transparent conductive coating to the photosensitive selenium surface, and electrically separating the cells by making an incision through the conductive coating and through the photosensitive surface coating, said incision extending along and at least to the amorphous selenium in the gaps between the plates.

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WALTON E. BRIGGS.
JOHN F. WEARY.

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