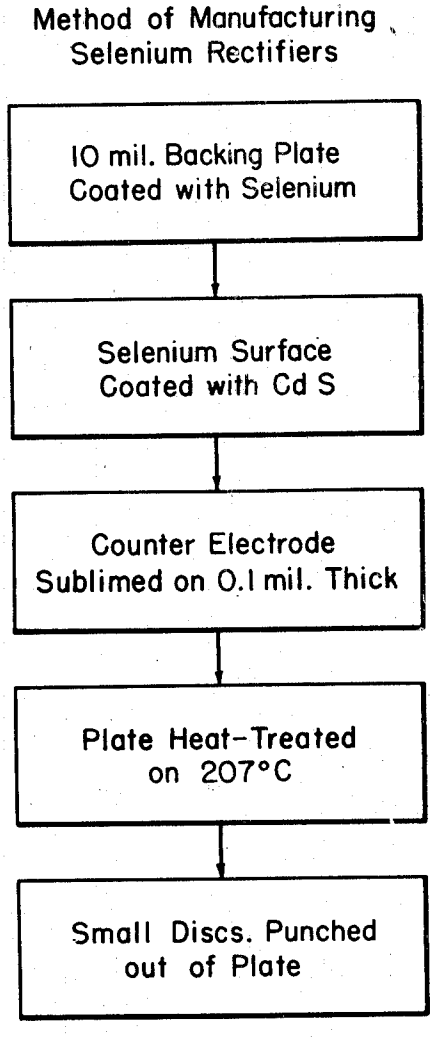
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METHOD OF MANUFACTURING SMALL CURRENT SELENIUM RECTIFIERS

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METHOD OF MANUFACTURING SMALL CURRENT SELENIUM RECTIFIERS

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My invention relates to selenium rectifiers and, in particular, relates to a method or process for manufacturing such rectifier units having extremely small current ratings, such as of the order of two milliamperes.

One object of my invention is to provide an improved method of manufacturing selenium rectifier elements in large quantities where the size of the individual unit rectifiers is of the order of one-eighth of an inch in diameter.

Another object of my invention is to provide an effective and economical method of manufacturing selenium rectifier units of extremely small diameter by punching them from selenium rectifiers having the form of sheets of much larger longitudinal dimensions.

Still another object of my invention is to provide a process by which selenium rectifiers may be punched from larger rectifier units having the form of thin sheets of considerable surface area without the danger of leaving metallic burrs short-circuiting the units after the final punching.

Other objects of my invention will become apparent upon reading the following description of preferred processes for carrying out the principles thereof. The attached drawing schematically illustrates such processes.

For certain purposes, such as, for example, producing voltage sources capable of furnishing extremely small currents, of the order of milliamperes, at voltages of the order of many thousands, it is desirable to make up selenium rectifiers comprising unit rectifier disks of the order of a small fraction of an inch in diameter, electrically connected in series with each other, in sufficient numbers to yield direct-current output voltages of the order of from 10,000 to 15,000. Since the rectifier elements can withstand something of the order of 30 volts per unit disk, this means an aggregation of several hundred small-diameter disks. For example, to produce output currents of 2 milliamperes, I have found that disks about an eighth of an inch in diameter may be employed. The production of extremely large numbers of such small-diameter disks offers a problem of considerable technical difficulty if it is to be done economically.

The process which I have found to solve the foregoing problem is scheduled in the drawing in a way believed to be self-explanatory and consists in first forming selenium rectifiers in sheets of substantial diameter, and thereafter punching disks of a diameter of about an eighth of an inch from the sheet rectifier thus formed. In

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accordance with this process, I may, for example, take washers stamped from nickel sheet 10 mils thick, having one surface sand-blasted. Six pairs of such disks are mounted back to back on a spindle with a quarter-inch spacing between the pairs. They are then coated with selenium which contains 0.01% of bromine by submerging the spindle in a molten bath of that material maintained at 350° C. The spindles are preferably rotated slowly while in the bath, and upon withdrawal therefrom, are rotated at a sufficient speed so that centrifugal force carries off a large part of the molten selenium, leaving a layer having a thickness of about 2 mils on the nickel. After cooling, the disks are disassembled and the surface of the selenium layer is coated with a full green film of cadmium sulphide by evaporating the latter in vacuo and permitting it to condense on the selenium surface. A 1 mil layer of an alloy comprising 80% cadmium and 20% tin is sprayed onto the disks, a suitable mask being provided for protecting the edges of the disks from such coating. The disks are then heat treated at 120° C. for 80 minutes and thereafter submitted to a further heat treatment at 207° C. for 135 minutes. Thereafter the disks are connected in an electric circuit which impresses a direct-current voltage in their normal non-conductive direction, such voltage varying from 30 volts at the beginning of the period and rising gradually to 70 volts at the end of two hours. During this so-called electrical formation, the disks are cooled by air blasts.

The sheet rectifiers thus produced are then punched up into small units about an eighth of an inch in diameter. It is found that if this is done with an ordinary punch and die, the sharp edges of the punch damage the portion of the barrier layer of the rectifier around the periphery of the unit and, furthermore, is likely to create a short-circuit between the counter electrode of cadmium alloy and the metal base of nickel by causing metal to flow plastically to produce bridges between the two under action of the pressure. I have, however, found that the damage to the barrier layer may be avoided by inserting a sheet of stiff paper between the cadmium alloy side of the sheet and the die, thus distributing the punching forces sufficiently to keep the pressures below the critical value at which such damage results. The difficulty from metal bridging between the base plate and counter electrode is corrected by dipping the finished disks in an etching solution comprising 10% nitric acid in distilled water at room temperature. The small punched

disks may be loaded into a basket of nickel wire screen; dipped into the above-mentioned solution for 5 minutes; the basket and its load being thereafter rinsed thoroughly with tap water, then with distilled water and thereafter dried in a strong blast of air, followed by baking in an oven at 120° C. for 30 minutes. Any paper adhering to the disks as a result of the punching process is automatically loosened and washed away in this procedure.

I have discovered an alternative method of avoiding the short-circuiting caused by the metal bridges in the punching operation. Instead of coating the selenium surface with the above-mentioned alloy of cadmium and tin to a thickness of about a mil, as above described, the alloy may be applied to the selenium surface of a thickness of only about one-tenth of a mil, preferably by evaporation and sublimation. With the counter electrode put on in this fashion, the short-circuiting is found not to occur during the punching operation.

Rectifier elements made in accordance with my process may conveniently be assembled into high-voltage low-current rectifiers by providing fiber tubes having central holes slightly larger in diameter than the disks and filling the desired length of these tubes with disks made according to the method above-described. End connections of the tubes may comprise brass ferrules, and a firm connection between the successive disks may be maintained by providing a proper spring to exert pressure between one ferrule and the top unit of the stack in the tube.

I claim as my invention:

1. The process of producing selenium rectifiers which comprises first producing selenium rectifiers having counter-electrodes in the form of sheets having extended area, covering one face of the sheet rectifier with stiff paper, thereafter punching small rectifiers out of such sheets, and

thereafter immersing the punched units in a chemical solution having a solvent action on the counter-electrode material.

2. The method of producing selenium rectifiers of small surface area which comprises coating a backing plate having a thickness of the order of 10 mils with a layer of selenium having a thickness of the order of 2 mils, coating the surface of the selenium with a film of cadmium sulphide, depositing on the surface of the sulphide a counter electrode having a thickness of the order of 0.1 mil, and thereafter subdividing said sheet into units of the desired surface area by a punch-pressing operation.

3. The method of producing selenium rectifiers of small surface area which comprises coating at least one face of a 10 mil nickel sheet with a layer having a thickness of the order of 2 mils by immersing said sheet in molten selenium containing 0.01% bromine maintained at about 350° C. and spinning off the excess coating, coating the selenium surface by evaporation with a film of cadmium sulphide, coating the surface of said sulphide with a counter electrode to a thickness of about 0.1 mil by sublimation thereon of a metallic vapor to form a counter electrode, facing said counter electrode with a layer of stiff paper, and subdividing the unit thus formed into smaller rectifiers of the surface area desired by a press-punching operation.

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