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PRESSURE RESISTANT INSULATORS FOR SELENIUM RECTIFIERS

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FIG. 1.

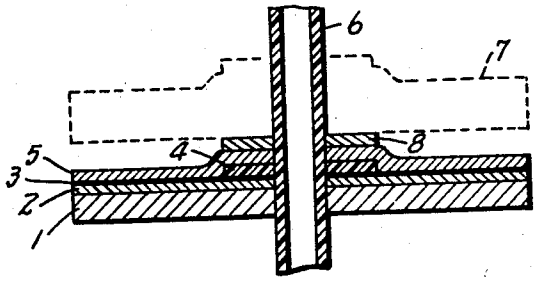
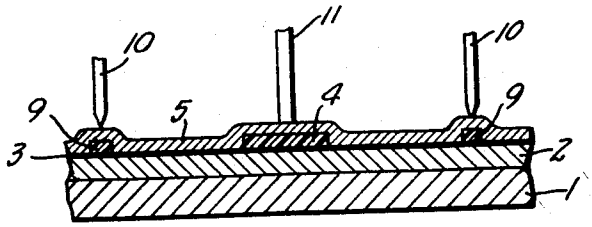


FIG. 2.



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PRESSURE RESISTANT INSULATORS FOR SELENIUM RECTIFIERS

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6 Claims. (Cl. 317—234)

This invention relates to pressure resistant insulators for selenium rectifiers and is a continuation-in-part of our application entitled "Selenium Rectifier Center Contact Washer," Serial No. 507,802, filed May 12, 1955, and now abandoned.

Dry contact rectifier plates or cells are generally assembled in "stacks" in order that higher A.-C. voltages may be rectified than would practically be possible with a single disc. Each cell consists of a base plate, usually made of an aluminum sheet plated with nickel, a layer of selenium deposited on the base plate, a barrier layer formed on the selenium, a contact insulating washer of smaller diameter, and a counterelectrode deposited over the insulating washer and barrier layer. The cells may be provided with a centrally located aperture and be stacked coaxially on an insulating tube or they may be stacked within a frame with the connections near their outer periphery. Metallic connectors or spacers are mounted between the counterelectrode of one element and the base electrode of the adjacent element to provide electrical connection between the cells of the stack.

In metallic rectifier stacks, insulating washers have long been used between the counterelectrode layer and the selenium body to prevent breakdown of the selenium when the rectifier plates are assembled in a stack and subjected to a high compressive force, to maintain the stacked assembly. The washer also prevents breakdown of the selenium during continued operation when variations in temperature produces corresponding variations in pressure between the plates.

Further, when rectifier plates are cut from a blank which is in effect a large rectifier cell, insulator strips are provided on the blank where the blank is cut up into the individual cells. The insulator strips serve to reduce short circuits while cutting the separate rectifiers from the blank.

For both of the above-mentioned purposes, paper insulators have been used with good results. However, the expense of laying separate insulators on each disc is considerable when large production is contemplated. Consequently insulating pressure washers, and the like, have been provided by use of an insulating varnish or compound. Many types of insulating compounds have been developed to replace paper washers over the past few years. Phenolic washers and polyvinylchloride base washers have been used, but difficulties have been encountered therewith. For example, a commonly used washer is made of polyvinylchloride lacquer but it has been found that this lacquer has poor adhesion to the counterelectrode, and being of a thermoplastic nature, has a tendency to flow when pressure is applied to the center of the stack. A further disadvantage of the polyvinylchloride base washer is its comparatively poor mechanical strength. For example, the washer scratches rather easily and cannot be subjected to operating temperatures exceeding 90° C. without melting or burning.

Also an epoxy resin, composed of a reaction product of bis-phenol (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) known under trade

names of Araldite and Epon have been tried for this purpose. This material, used in its clear state, had poor adhesion to the selenium and counterelectrode alloy.

Moreover, rectifiers made with these prior art compounds produce short circuits upon breakdown, putting a heavier voltage across the remaining rectifier cells in a stack. This higher voltage tends to cause breakdown of the other cells.

According to this invention, it has been found that if an epoxy resin of the type described above is mixed with an inert filler, and an amine hardener is added, a superior type of pressure insulator for selenium rectifiers is produced. Rectifiers using insulating contact washers of this type have good adhesion between the selenium and the compound and between the counterelectrode and the compound. The material will withstand relatively high operating temperatures without failing, and the tendency to breakdown is greatly reduced.

Furthermore, a totally unexpected result of using this material has been discovered. Failures of rectifier cells with this new compound have been found to be much fewer than with the formerly used polyvinyl compounds. Surprisingly, such failures as do occur appear as open circuits rather than short circuits. The reason for this effect is not known, but has been found to exist with these epoxy materials according to the invention, used with amine hardeners. It is considered probable that some of the amine, used as a hardener, diffuses into the selenium below the pressure contact area of the insulator causing an increase in resistivity of the selenium in the vicinity of this insulator.

It is an object of this invention to provide a pressure resistant insulator for selenium rectifiers which is superior to washers heretofore known.

It is a further feature of this invention to provide a process for making a pressure resistant insulating compound for selenium rectifiers.

In accordance with an aspect of the invention, there is provided a selenium rectifier having a pressure resistant insulator for selenium rectifiers consisting essentially of a reaction product of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and in intimate mixture therewith an inorganic filler and an amine hardener.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing in which:

Fig. 1 is a cross-sectional view of a selenium rectifier stack showing one element in cross-section and the next adjacent element in dotted line; and,

Fig. 2 is a sectional view of a portion of a plate illustrating the use of the pressure resistant insulating material of the invention in cutting individual discs from a larger plate.

Referring to Fig. 1 there is shown a rectifier comprising a rectifier cell consisting of a base plate **1**, a coextensive selenium layer **2**, a barrier layer **3** (shown solid), a center contact insulating washer **4** and a counterelectrode **5**. The parts are centrally apertured, as shown, and are assembled coaxially over an insulating tubing **6**. A second rectifier element is shown by dotted line at **7**. Electrical contact is made between the rectifying cells by providing a conductive connector **8** positioned between the counterelectrode of one rectifying cell and the base electrode of the next adjacent rectifying cell.

In Fig. 2 there is shown a portion of base plate material **1**, covered with a selenium layer **2**, a barrier layer **3**, a center contact insulator washer **4**, and other strips of pressure resistant insulating compounds **9**. Strips **9** are positioned under cutters **10**, and washer **4** under a

center punch 11. When these cutters and punch are used to stamp out a rectifier, such as shown in Fig. 1, the pressure resistant insulators prevent the counterelectrode layer from being pressed into contact with the base producing a short circuit.

The pressure resistant insulators 4 and 10 are prepared by mixing the reaction product of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and an inorganic filler. The inorganic filler may be, for example, calcium carbonate, diatomaceous silica, a mixture of these, talc, or any one of the other well known fillers used in electrically insulating compounds. The above reaction product, which is an epoxy resin manufactured under the trade names of Araldite and Epon, is a heavy viscous liquid. The inorganic filler is a solid in powder form which is rolled and milled with the Araldite until a homogeneous mixture is obtained. A ketone type solvent such as for example, diacetone, acetone, methylisobutyl ketone or methylethyl ketone, is added to the highly viscous mixture, in order to make it more suitable for application to the cells and to increase the pot-life of the mixture. When the composition is ready to be used an amine hardener is added which for example may be triethylenetetramine or diethylenetriamine. The amount and activity of the hardener used determines the rapidity at which the material hardens or cures.

The quantity of the various ingredients is determined, in large part, empirically.

A preferred example of insulating material being used in the production of selenium rectifiers is approximately as follows:

346 parts by weight of epoxy resin described above;
750 parts by weight of an inorganic filler e.g., 675 parts by weight of calcium carbonate; 75 parts by weight of an inorganic filler, essentially diatomaceous silica;
212 parts by weight of a solvent, preferably "Cellosolve" acetate, "Cellosolve" is the trade name for 2-ethoxy ethanol;
16 parts by weight of a polyamine hardener; and
10 parts by weight Bentone 18–C, an organic compound of hydrous aluminum silicate clay having the property of keeping the inorganic fillers in suspension by forming gels.

While the compound set forth above is preferred, we have found that the insulating compound composed approximately of the following ingredients is quite satisfactory.

100 parts by weight of the epoxy resin described above;
15 parts by weight of diatomaceous silica;
15 parts by weight of diacetone alcohol; and
5 parts by weight of triethylenetetramine as hardener.

In each of these compositions the material may be mixed without the added hardener for storage purposes, the hardener being added and mixed thoroughly into the composition just prior to its use.

The compositions as described above have been applied to the rectifier cells by a silk screen process. By way of example, a small quantity of this composition was placed on a silk screen, the barrier layer of the rectifier cell being adjacent to the underside of the silk screen. The screen includes a pattern in the form of the pressure resistant insulators and the material is applied to the barrier layer by running a squeegee over the silk screen forcing the composition through the interstices of the

screen defining the pattern. The composition deposited on the barrier layer is permitted to dry for 10–30 minutes at room temperature and baked at a temperature of 85° C. for approximately 30 minutes. The counterelectrode alloy is then sprayed or vacuum deposited over the composition and exposed barrier layer.

Washers produced in accordance with the method of this invention are capable of withstanding pressure greater than twice the pressures which could be applied to washers of the prior art without failure. The washers are also capable of operating without failure at temperatures of 160° C.–170° C. which are considerably greater than the safe operating temperatures permitted when using polyvinylchloride center washers.

Although this invention has been described in connection with a rectifier stack in which contact is made over a small central area so that an insulating washer is desirable, it should be distinctly understood that the washer may be of different form and may be positioned elsewhere than the center. The insulating washer is positioned at contact pressure areas wherever they may be located.

While we have described above the principles of our invention in connection with specific compounds, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. A pressure resistant insulator for selenium rectifiers consisting essentially of a reaction product of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and an aliphatic amine; and in intimate mixture therewith an inorganic filler.

2. A pressure resistant insulator according to claim 1, wherein said aliphatic amine is a polyamine.

3. A pressure resistant insulator according to claim 1, wherein said inorganic filler consists substantially of 9 parts calcium carbonate and 1 part essentially diatomaceous silica.

4. A selenium rectifier having a body of selenium and conductive electrodes on different surfaces of said body and an insulating spacer between said body and predetermined areas of a conductive electrode, subject to pressure, consisting of a reaction product of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and an aliphatic amine; and in intimate mixture therewith an inorganic filler.

5. In a selenium rectifier, a contact insulating washer consisting essentially of a reaction product of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and an aliphatic amine; and in intimate mixture therewith an inorganic filler.

6. A rectifier comprising a base plate, a selenium layer, a barrier layer, a contact insulating washer and a counterelectrode, the washer consisting essentially of bis-phenol A (4,4'-isopropylidenediphenol) and epichlorohydrin (1-chloro-2,3-epoxypropane) and an aliphatic polyamine; and in intimate mixture therewith an inorganic filler.

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