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2,198,843

METHOD OF MAKING A RECTIFIER ELEMENT

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Fig. 1

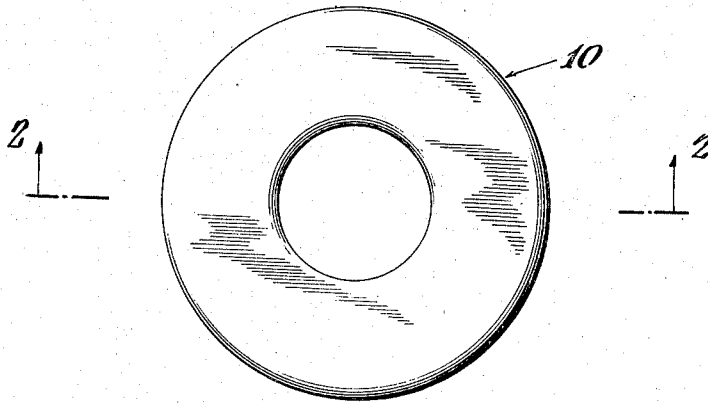


Fig. 2

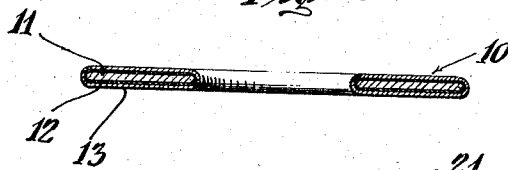
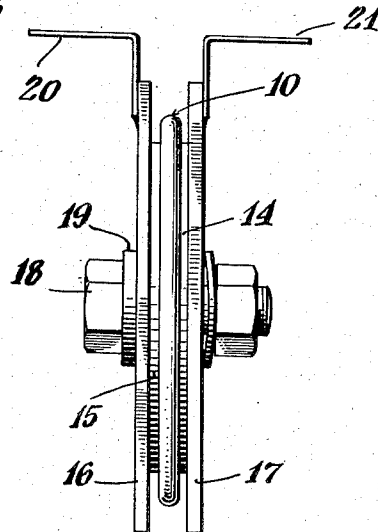


Fig. 3



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METHOD OF MAKING A RECTIFIER
ELEMENT

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6 Claims. (Cl. 175—366)

This invention relates to electrode elements for dry disc rectifiers and methods of manufacturing the same.

5 An object of the invention is to improve such electrode elements.

Another object is to improve the method of manufacture of said elements.

10 Other objects of the invention will be apparent from the following description and accompanying drawing taken in connection with the appended claims.

The invention comprises the features of construction, combination of elements, arrangement of parts, and methods of manufacture and operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawing:

20 Figure 1 is a face view of an electrode disc element for dry disc rectifiers;

Figure 2 is a section on the line 2—2 of Figure 1; and

25 Figure 3 shows a complete rectifier assembly.

This invention relates to the elements for rectifiers of the type described in my Patents 1,751,359, 2,032,439 and other of my patents dealing with dry disc electric current rectifiers. The invention is particularly concerned with the improvement of the electronegative electrode elements, usually discs or washers formed of copper compounds such as cupric sulfide. In my above mentioned patents I have described the use of a copper alloy as a base material for the production of the cupric sulfide electrode discs for use in the rectifier, such as magnesium-cupric sulfide junction rectifier. The preferred copper alloy is an alloy of copper with less than 20% of zinc, preferably 85% copper and 15% zinc.

According to prior methods of making the elements the alloy was rolled into thin sheet form and discs were stamped from the sheet. The discs were then treated with sulphur to convert the copper and zinc to sulfides. In the process of sulfiding an alloy disc a sulfide disc is produced having a core of relatively homogeneous zinc sulfide containing a small amount of cuprous sulfide. Surrounding this core is an extended structure of cupric sulfide having long parallel needle crystals disposed with their ends adjacent the core and the surface of the disc. In addition, a thin intermediate layer is discernible closely disposed about the core and consisting of cupric sulfide of not quite as regu-

lar structure as the outer layer but having an irregular fracture.

The growth of the crystal needle structure about the central core in the electrode is apparently accompanied by a migration of the copper from within the core region to a point near the surface and there appears to be an exchange or metalepsis of sulphur for copper in the space originally occupied by the copper alloy in the region of the core.

10 Formation of the distinct layers of compound of the two constituents is necessarily slow and the reacting periods must be of sufficient duration to allow for migration of the copper and for the so-called metalepsis of the sulphur for the copper and growth of the layer of cupric sulfide. Adequate time is also required to convert any cuprous sulfide formed in the reaction into cupric sulfide.

While, for many cases, good cupric sulfide discs can be produced by the reaction of sulphur with the copper zinc alloy I have found that where the discs are subsequently machine ground to afford a smooth contacting surface that there is a considerable percentage of breakage during the grinding operation, especially in the larger discs. This cracking seems to be due to insufficient bonding between the cupric sulfide layer and the zinc sulfide core since frequently the cracking is accompanied by a peeling off of the cupric sulfide from the core.

30 While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

By my present invention I have improved the character of the sulfide disc and obtained a better bond between the cupric sulfide layer and the core of zinc sulfide. I achieve this by a mercury treatment, preferably by treating the copper zinc alloy with mercury or a mercurous salt prior to sulfiding. I prefer to treat the copper zinc alloy discs so as to produce a superficial layer of mercury or mercury amalgam on the surface of the disc prior to sulfiding. It appears that this treatment results in some change in the reaction or in the structure during the sulfiding operation so that a sulfided disc is produced having a much higher degree of bonding

between the cupric sulfide layer and the zinc sulfide core in the finished disc. These discs may be machine ground to produce plane contacting surfaces with practically no loss due to cracking; whereas with the prior discs a substantial percentage had to be rejected after the grinding operation.

While I do not wish to be limited to any particular theory of operation I believe that the function of the mercury is to retard the initial sulfiding to an extent sufficient to result in a denser structure in the finished disc. It is believed, however, that the mercury is lost after the initial sulfiding is completed since there is little evidence of any mercury or mercury compounds in the finished discs.

According to the preferred method of practicing my improved process the copper-zinc alloy discs are first cleaned in a 40 to 50% by volume solution of nitric acid, rinsed in water, then immersed in a solution of mercurous nitrate. The mercurous nitrate solution should preferably be of fairly high concentration and should be in contact with liquid mercury to maintain its mercury content during use. After immersion in the mercurous nitrate bath, the discs are rinsed in water and placed on a rack, dried and slowly immersed in a bath of liquid sulphur, the sulphur being at a temperature of about 120 degrees C., where it is most fluid. The temperature of the sulphur is then gradually raised to 444.6 degrees C. during a three-hour period and is maintained at that temperature for about 16 hours. The discs are then raised out of the sulphur bath just above the level of the sulphur so that they remain in the sulphur vapor atmosphere and the excess sulphur drains off. The heat is then discontinued from the sulphur bath and the discs are allowed to cool slowly.

The sulfide discs are of a deep blue color of pure cupric sulfide and have a core of gray zinc sulfide to which the cupric sulfide is strongly integrally bonded. They withstand heating and cooling without cracking into separate layers. Considerable heating is usually encountered in the grinding operation and this ability to withstand changes in temperature is a great advantage.

While the preferred copper alloy is one of 85% copper and 15% zinc, other percentages of zinc can be used and likewise other elements than zinc can be used in combination with the copper, for example: tin, chromium, aluminum. Also, in some cases other materials than sulphur can be combined with copper alloy to produce a suitable copper compound, such as selenium or tellurium, these materials likewise being capable of forming an electronegative compound affording a rectifying junction in combination with a layer of electropositive material such as aluminum, magnesium or cadmium.

In the drawing Figures 1 and 2 show a cupric sulfide rectifier disc 10 produced according to the present invention and having a core 11 composed

principally of zinc sulfide, an intermediate thin layer 12 of cupric sulfide crystals in a somewhat irregular structure and an outer layer 13 of cupric sulfide crystals in a needle-like structure extending from the intermediate layer to the surface.

Figure 3 shows a complete rectifier assembly comprising disc 10 in surface contact with a disc 14 of electropositive metal such as magnesium on one side and a non-polarizing layer 15 of carbonized nickel or the like on the other side. This assembly is clamped together between two radiator and terminal plates 16 and 17 by a bolt 18 passing through the center of the discs and insulated from plate 16 by a suitable insulating washer 19. Electrical connections 20 and 21 are made to plates 16 and 17 for connecting the rectifier in an electric circuit for rectifying purposes.

While the present invention as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. The method of making a cupric sulfide rectifier element which comprises applying a layer of mercury to the surface of a member formed of an alloy of copper and subsequently reacting said member with sulfur at an elevated temperature to an extent sufficient to convert the copper to cupric sulphide.
2. The method of making a cupric sulphide rectifier element which comprises applying a layer of mercury to a brass member and subsequently reacting the member with sulphur.
3. The method of making a cupric sulphide rectifier element which comprises applying a layer of mercury to a brass member and subsequently reacting the member with sulphur at an elevated temperature to an extent sufficient to convert the copper to cupric sulphide.
4. The method of making a cupric sulfide rectifier disc which comprises forming a disc of brass, amalgamating mercury with the surface thereof and then reacting the disc with sulfur at an elevated temperature to convert the copper and zinc to sulphides.
5. The method of making a rectifier element which comprises applying a layer of mercury to the surface of a member formed of an alloy of copper and subsequently reacting said member with one of the elements sulphur, selenium or tellurium at an elevated temperature to an extent sufficient to convert said member to a compound of copper and the element with which it has been reacted.
6. The method of making a rectifier element which comprises applying a layer of mercury to a brass member and subsequently reacting the member with one of the elements sulphur, selenium or tellurium.

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