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METHOD OF ROUGHENING STEEL

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Fig. 1

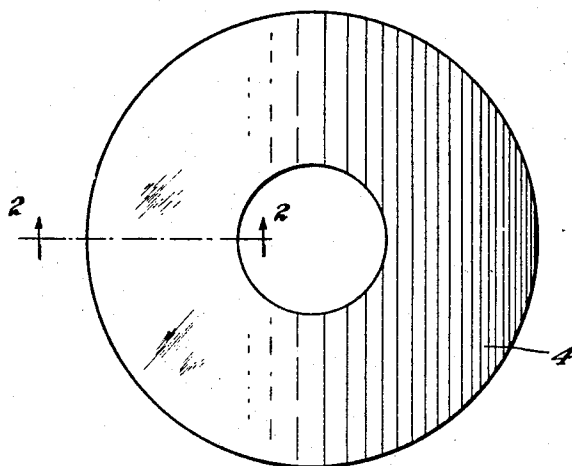
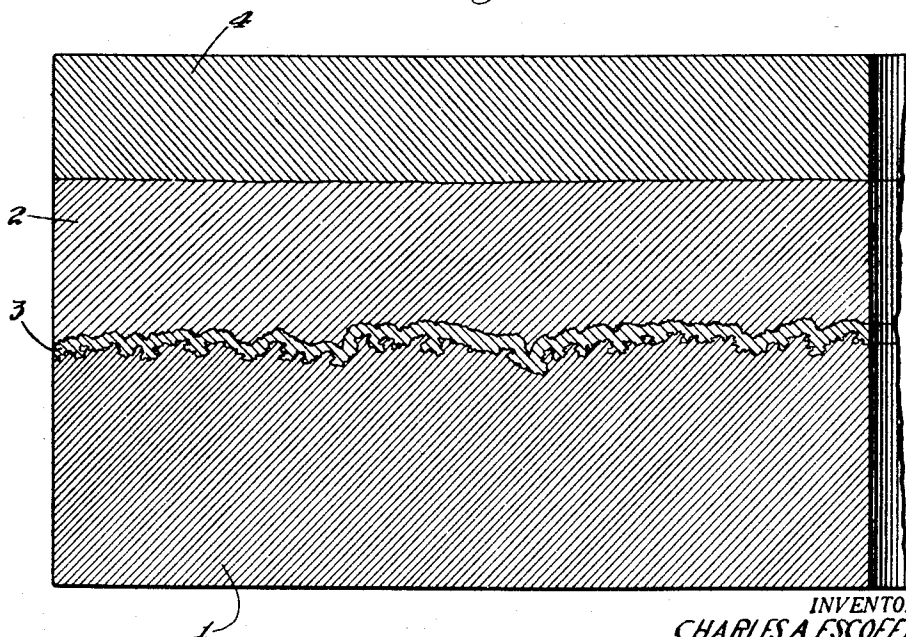


Fig. 2



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METHOD OF ROUGHENING STEEL

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7 Claims. (Cl. 41—42)

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This invention relates to novel articles of manufacture and to methods for preparing the same. In its more specific aspect the invention is directed to novel rectifiers, parts thereof and to methods for preparing the same. The rectifiers with which this invention is more particularly concerned are those generally known as the dry or dry disc type.

These dry rectifiers generally consist of a ferrous base plate carrying thereon a layer of selenium on top of which is an eutectic alloy, such as Wood's alloy. In some instances between the ferrous base and the selenium layer there may be a thin layer of nickel, iron or the like.

Figure 1 is a top plan view of a dry rectifier embodying the present invention.

Figure 2 is a cross sectional view taken on line 2—2 of Figure 1, said view being greatly magnified.

The general process employed in producing a selenium rectifier consists in applying a layer of selenium to a metallic base plate, such as iron and usually steel and then spraying on to the layer of selenium a layer of a fusible eutectic alloy, such as Wood's alloy. The metallic base plate and the alloy constitute the two electrodes of the rectifier.

In practice no serious difficulties are ordinarily encountered in applying the alloy, but experience has shown that in order to insure the adherence of the selenium to the base plate, it is necessary to roughen the surface of the latter. This surface roughening generally has been accomplished by blasting with an abrasive such as sand, during which treatment surface oxides may also be removed.

It has long been known that while this sand-blasting treatment produced a surface on the base plate which provided a better adherence surface for selenium thereto than the untreated base plate, this adherence characteristic was only moderately good and therefore was far from being completely satisfactory. Other disadvantages of sandblasting are that sometimes sand particles are embedded in the so-treated base, that it is costly, time consuming, noisy, inconvenient, and that it presents a silicosis hazard. Consequently, attempts have been made to treat the base metal in various manners in order to provide a better adhering surface between the base and the selenium. All of these have failed for one reason or another and generally because such treatments introduce an electrical resistance in the completed rectifier which is reflected as a low forward grade or a low forward conductivity characteristic.

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In the course of my experimentations, I have discovered that I may produce dry disc rectifiers which are superior to the prior art rectifiers of this type. I have further found that I may treat the base metal to provide a surface which has improved adherence where selenium is deposited thereon. This treatment is silent, fast, easily controlled and relatively inexpensive. In addition it presents no hazard to health and does not introduce an additional electrical resistance in the rectifier.

Briefly, in carrying out this invention I prefer to employ a ferrous base plate 1 and preferably one whose carbon content is no greater than about .5%. While pure iron may be employed, for economic reasons I prefer to employ steel having a hardness no greater than 90 on the Rockwell B scale and a carbon content no greater than about .5%. The carbon content of the steel may vary between .05% and .5% and these steels have SAE numbers between 1010 and 1050. The base plate 1 may be first made to shape and size in any desired manner. This so-called ferrous base blank 1 is then subjected to a cleaning operation to remove the oil, grease and dirt thereon. While any number of different methods may be employed for this purpose, I prefer to accomplish that purpose by employing either an alkali soak cleaning or an alkali electrocleaning step and more preferably the latter. For this cleaning step I prefer to employ an alkali cleanser, such as "Oakite #90" manufactured by the Oakite Products, Inc., of New York, New York. A water solution of said "Oakite #90" is made up with the concentration of said solution being about 8 ounces "Oakite #90" per gallon of water. The solution is heated to about its boiling point or about 5 to 10 degrees F. therebelow and said blanks 1 are placed therein and are connected to the positive pole of a source of E. M. F.; the negative pole is connected to the container of said solution, and this container may also be steel, but it is preferable to employ separate steel elements immersed in said solution as the cathodes. The current density of the anode or blank 1 being treated in said solution at said temperature is about 50 amperes per square foot. At the end of a few minutes, the blanks 1 will be found to be clean and are removed from said solution. Then the blanks are rinsed in a warm water bath. By whatever method employed, the cleaned ferrous base blanks 1 are now ready for treatment to roughen or deep etch the exterior surface thereof.

According to this invention, these cleansed ferrous base blanks 1 are immersed in a novel etch-

ing solution in order to deep etch or roughen the same. This solution may consist of an aqueous solution of nitric acid, and the normality of said solution may be between about 0.5 and 6 and for best, quickest and most efficient results the normality of the solution is between 2.5 and 6. During treatment of said blanks 1 the temperature of the solution is maintained in any convenient manner between about 15° C. and 60° C. The bath or solution may be constantly stirred or agitated by means of a mechanical stirrer or by air agitation to improve the appearance of the discs or blanks, to prevent stratification and to aid in leveling the temperature of the solution throughout its mass. After a period of about 5 to about 10 minutes in said solution depending on the normality thereof, the blanks 1 are removed and immediately thereafter are rinsed with water to prevent discoloration and streaking. After immersion in said bath, the surface of each blank 1 will be found to have a roughened surface consisting of pits, elevations and irregularities for locking selenium thereto and thus providing good adherence characteristics. Upon removal of said blanks 1 from said solution and even after the rinsing operation they will be found to have a coating of smut thereon.

This smut may then be removed therefrom and preferably by the method described in my application Ser. No. 578,226, executed by me on February 3, 1945, and filed February 16, 1945, and hereby made part hereof, or by employing an alkali electrocleaning step. This alkali electrocleaning step involves using an alkali cleanser such as "Oakite #90" manufactured by the Oakite Products, Inc., of New York, New York. A water solution of said "Oakite #90" is made up with the concentration of said solution being between about 10 to 12 ounces of "Oakite #90" per gallon of water. The solution is heated to about its boiling point or about 5 to 10° F. therebelow and said blanks are placed therein and are connected to the positive pole of a source of E. M. F.; the negative pole is connected to the container of said solution, and this container may be composed of steel, but it is preferable to employ separate steel elements immersed in said solutions as the cathodes.

The current density of the anode or blank being treated in said solution at said temperature is approximately 50 amperes per square foot. At the end of approximately 3 minutes the blanks will be found to be cleaned and to have been demutted and are then removed from said solution and rinsed in water.

After said rinse, the blank 1 is dipped for approximately a minute or so in a dilute mineral acid such as sulphuric or hydrochloric acid at room temperature. For this purpose it is preferable to employ an aqueous solution of hydrochloric acid and the concentration of said solution may be between about 10% to 25% of the hydrochloric acid by volume. This solution may be made up by employing one part of hydrochloric acid (20° Baumé) to between about three to about nine parts of water.

Upon removal of the smut, the surface of each blank 1 presents an exposed surface characterized by a number of pits, elevations and irregularities for locking the selenium thereto and thus provide good adherence characteristics. The deep etching produced by this invention exhibits a marked degree of undercutting (shown in Figure 2) which is probably the cause of the excellent adherence of a selenium layer 2 added

thereto, and in addition shows a much greater surface area when compared with a sandblasted surface. If desired an intermediate layer of nickel, iron, cobalt 3 or the like may be deposited on the etched surface of said ferrous base 1, after which the layer 2 of selenium may be deposited thereon. Either with or without the intermediate layer, the selenium layer 2 will have good adherence to said roughened surface and good electrical characteristics. On to said selenium layer 2 may be deposited a layer 4 of a fusible eutectic alloy, such as Wood's alloy.

While the use of said nitric acid solutions have been found eminently satisfactory for the treatment of said metallic base members 1 for roughening or etching the surfaces thereof, I have found that in some cases and especially when said solutions of high normality and between 3 and 6 normal are used, it sometimes happens that the deep etching or roughening is not always uniform throughout. I have found that by adding sulphuric acid to said solution, this may be corrected so that the treated surface will have good adhesion properties to selenium throughout. The quantity of concentrated sulphuric acid in said solution is preferably controlled within narrow limits and is no greater than 0.2% by volume and preferably between 0.01% and 0.1% by volume. By employing said sulphuric acid and particularly in the aforesaid proportion in a .5 to 6 N and preferably in a 2.5 to 6 N aqueous solution of nitric acid, I am able to produce roughened or deep etched surfaces having improved adhesion characteristics with selenium throughout the entire area thereof especially when the base 1 is a low carbon steel having a carbon content between 0.05 and 0.5% and having a hardness no greater than 90 on the Rockwell B scale and is deep etched or roughened in one of said solutions.

In the practice of this invention, I first prepare a 0.5 N to 6 N and preferably a 2.5 N to 6 N and more preferably an approximately 4 N aqueous solution of nitric acid. Said approximately 4 N aqueous solution of nitric acid is prepared by mixing one part by volume of concentrated nitric acid (67 to 71% HNO₃) with three parts by volume of water. To any of said solutions may be added a quantity of concentrated sulphuric acid (93 to 98% H₂SO₄) measuring no more than 0.2% by volume and preferably between 0.01 and 0.1% by volume based on the volume of said solution. The solution either without, or preferably with said sulphuric acid has immersed therein a metallic base blank and preferably a carbon steel blank having a carbon content no greater than about 0.5% and preferably between about 0.05 and 0.5% and a hardness no greater than 90 and preferably no lower than 30 on Rockwell B scale. The steel blank is allowed to remain in one of said solutions for a period of about .5 to 10 minutes during which time said solution is agitated and maintained between about 15° C. and 60° C. Then the so treated blank is removed from said solution, rinsed in water and the smut thereon is removed therefrom.

The smut may be removed from said etched blank in any desired manner and according to the teachings of the aforeidentified application or by the method herein described. After the smut has been removed, the blank is rinsed in warm water and dipped in said dilute mineral acid bath. Then the roughened or etched surface thereof may have deposited thereon a layer of selenium and on to said layer of selenium is

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deposited a layer of a fusible eutectic alloy such as Wood's alloy. Instead of depositing the layer of selenium directly on to said etched surface of said blank, a layer of nickel, iron, cobalt or the like may first be deposited thereon prior to the deposition of the selenium layer. The dry rectifiers whose ferrous electrodes have been etched in accordance with this invention and with or without an intermediate layer between the selenium and said co-etched surfaces have improved electrical and mechanical properties.

While this invention has been described in considerable detail, it is not to be limited thereby because various changes and modifications may be made within the scope of this invention without departing from the spirit thereof.

I claim:

1. The method comprising roughening a surface of a low carbon steel having a carbon content no greater than 0.5% with a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between about 0.5 and 6 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being no greater than 0.2%.

2. The method comprising roughening a surface of a low carbon steel having a carbon content no greater than 0.5% with a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between about 0.5 and 6 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being between about 0.01% and 0.1%.

3. The method comprising roughening a surface of a low carbon steel having a carbon content no greater than 0.5% with a mixture of con-

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centrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between about 2.5 and 6 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being no greater than 0.2%.

4. The method comprising roughening a surface of a low carbon steel whose carbon content is between about .05 and 0.5% with a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being approximately 4 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being between about 0.01% and 0.1%.

5. A deep-etching bath comprising a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being approximately 4 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being between about 0.01% and 0.1%.

6. A deep-etching bath comprising a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between 0.5 and 6, and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being between about 0.01% and 0.1%.

7. A deep-etching bath comprising a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between 2.5 and 6, and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being no greater than 0.2%.

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