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H. KAHLER

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ELECTROLYTIC REDUCTION OF COPPER OXIDE SURFACE OF RECTIFIERS

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Fig. 1.

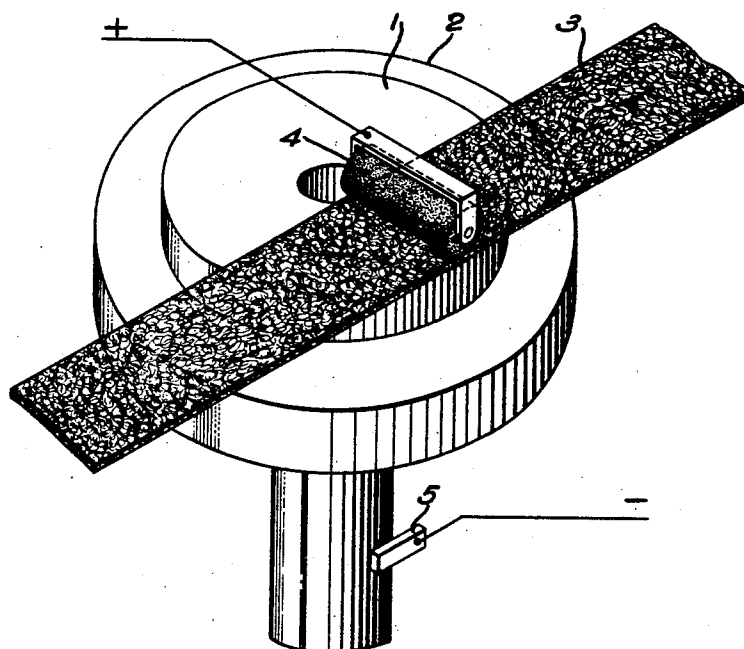


Fig. 2.



INVENTOR

INVENTOR
Herbert Kahler

BY *Herbert E. Carr*
ATTORNEY

ATTORNEY

UNITED STATES PATENT OFFICE

HERBERT KAHLER, OF KENSINGTON, MARYLAND, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

ELECTROLYTIC REDUCTION OF COPPER OXIDE SURFACE OF RECTIFIERS

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My invention relates to electrolytic apparatus and processes and particularly to means for producing chemical reactions by electrolytic decomposition at the surface of oxidized copper rectifier units.

One object of my invention is to provide means for electrolytically reducing the surface of a porous material without permitting an appreciable impregnation of the material by the electrolyte.

Another object of my invention is to provide a process for producing a contact surface on the oxidized layer of an oxidized copper rectifier unit.

A further object of my invention is to provide a process for producing an oxidized copper rectifier unit which has a low resistance to current flow in the conducting direction through the rectifier but a high resistance in the reverse direction.

Other objects of my invention will become apparent through reading the following specification taken in connection with the drawings, in which:

Figure 1 is a perspective view showing an apparatus for electrolytically reducing the surface of an oxidized copper disc suitable for a contact rectifier unit; and

Fig. 2 is a mid-sectional view of a rectifier disc produced by the methods of my invention.

Rectifiers comprising elements consisting of copper blanks having one surface oxidized, as a result of which such elements possess a uni-lateral electrical conductivity, are well-known in the electrical art. The problem of making an effective electrical contact with the free face of the oxide is one to which considerable attention has been given. One method of doing this which has been found effective from a practical standpoint consists in electrolytically reducing the surface of the oxide layer, by generating nascent hydrogen in contact therewith in a suitable electrolytic bath. However, it is found that the oxidized layer is seamed with numerous fine cracks and if the unit remains in the electrolytic bath for an extended period, the electrolyte penetrates the above-mentioned cracks and is found to increase the leakage

current which flows through the rectifier during those half-cycles when it should be non-conductive. Such current produces heating and general internal losses and is accordingly highly undesirable.

In accordance with my invention, I have provided a process by means of which the surface of the oxide layer of oxidized copper rectifier discs may be electrolytically reduced without permitting an appreciable quantity of electrolyte to penetrate into the cracks of the aforesaid layer. The method which I disclose is one adapted to the quantity production of rectifier discs and involves no expensive apparatus.

My invention also comprehends a method for reducing the resistance to current flow through the rectifier in its conductive direction and an increase of resistance to current flow in the non-conductive direction. I have found the desirable effects just mentioned to result from producing a polished surface on the oxide layer before subjecting it to electrolytic reduction. I have also found that similar results follow if the oxide layer is treated with a water solution of sodium or potassium cyanide prior to electrolysis. Furthermore, I find coating the surface of the oxidized layer with finely-divided carbon before electrolysis has an effect similar to that of polishing; and that by combining the foregoing processes, even better results follow than are obtainable by the use of any individual one.

With the foregoing principles and objects of my invention in mind, an oxidized copper element suitable for assembly into a contact rectifier is indicated at 1 in Figure 1. Such a rectifier element may be produced by heating a circular disc of copper with one of its surfaces exposed to contact with the air, to a temperature of approximately 1040 degrees centigrade for a period of about six minutes.

The disc may then be slowly cooled during the course of about one-half hour to approximately 600 degrees centigrade and may then be quenched in water or a stream of cold air. It is not difficult to so arrange the foregoing operations that only one surface of the copper disc is oxidized, but if through any chance the entire surface becomes oxidized,

the oxide layer may be removed by grinding or pickling the oxide from one side of the disc to expose the mother copper. While the precise process of treatment just given is for illustration only and constitute no part of the present invention, it will be understood that other methods of producing the oxidized layer, now known in the art, may be successfully employed in preparing the oxidized disc for the further process steps now to be described.

The oxidized copper disc 1 is supported upon a small rotating lap 2 with its oxidized surface uppermost. A ribbon of insulating chemically inert fabric, such, for example, as woven asbestos, passes horizontally across the face of the disc as indicated in Fig 1 which moves rapidly relative to this porous insulator. A roller 4, which may be of graphite, presses the ribbon 3 firmly into contact with the face of the rapidly revolving disc 1. The ribbon 3 is kept saturated with an electrolyte, such as copper sulphate, and moves slowly along under the roller 4. Current is conducted from the positive terminal of any suitable source of electromotive force into the roller 4, through the electrolyte saturating the ribbon 3 and across the junction between the ribbon 3 and the oxidized face of the disc 1. The current then flows from the unoxidized face of the disc 1 into the lap 2 and thence through a contact brush 5 to the other terminal of the aforesaid source of electromotive force. In accordance with well-known principles of electrolysis, nascent hydrogen will be evolved at the surface of the oxidized layer on the disc 1. The surface oxide will be reduced, thereby producing a layer of reduced copper which is found to constitute an effective electrical contact surface when the complete rectifier discs are assembled in circuit connection in ways too well known in the art to require description herein.

The lap 2 is maintained in continuous rotation and the electrical circuit is so adjusted as to produce a current density of approximately 20 amperes per square inch at the contact face between the ribbon 3 and the disc 1. Under such conditions, the small amount of electrolyte actually wetting the surface of disc 1 is almost instantaneously removed by the combined effect of electrolytic decomposition and the Joulean heat evolved in the relatively high resistance. As a result, there is no appreciable penetration of electrolyte through any cracks in the oxide layer and it is found that rectifier discs reduced in accordance with this process have a very small leakage current in the non-conductive direction.

Fig. 2 shows a cross-section of a rectifying element produced in the manner just described, 6 indicating the copper disc, 7 the layer of unreduced copper oxide and 8

the surface layer of copper reduced by the electrolytic process just described. It will be understood that the relative thickness of both the oxide and reduced copper layer are exaggerated for the purposes of clear illustration.

The rate of revolution of the lap 2 and the time during which the disc 1 is subjected to electrolytic reduction should be regulated so as to produce a firm and uniform contact surface of reduced copper on the oxide layer and should not be continued so long as to reduce the entire body of the oxide, all the way down to the mother copper.

While I have described the current as drawn from a direct current source, an alternating current source may be employed since the oxidized copper disc will itself rectify the current in such a way as to produce the desired electrolytic reduction at the oxidized surface.

It has been found that if the oxide layer on the disc 1 is polished by buffing with a fine abrasive or by other means well-known in the art, the resistance of the resulting disc, after electrolytic reduction of its surface, is less to current flow in its conductive direction, while its resistance to current flow in the reverse direction remains unimpaired. I accordingly contemplate as an adjunctive feature of my invention, the polishing of the oxide surface before reduction.

I have further found that if the oxide surface is properly treated by washing with a water solution of sodium or potassium cyanide before being subjected to the electrolytic reduction, the resistance to current flow in the conducting direction is decreased, whereas resistance to reverse current flow remains unaltered. A sodium cyanide solution of specific gravity 1.14 has been found to give satisfactory results, for instance.

I have likewise found that the resistance to current flow in the forward direction is decreased if the oxide surface is coated with finely-divided carbon, which may be in the form of finely powdered coke, before the electrolytic reduction of the surface layer is carried out. The treatment with powdered carbon just described results in no decrease of resistivity of the unit in the non-conductive direction.

While each of the foregoing methods of increasing the ratio of resistance in the non-conductive direction to resistance in the conductive direction may be employed individually with the electrolytic reduction process previously described, and while two or more of them may be employed in conjunction with each other with a yet further increase of the aforesaid resistance ratio, it will be understood that the employment of these methods of increasing the resistance ratio is not essential to, but merely adjunctive to, the

reduction process described in connection with Fig. 1.

It will also be appreciated that the above-described methods of increasing the aforesaid resistance ratio may be employed in connection with other processes of reducing the surface oxide than that here described, and that the polishing and cyanide treatments may be employed to increase the resistance ratio aforesaid when contact to the oxide layer is made by other processes than reduction to metallic copper; such, for instance, as mechanical contact of lead or other impressionable metal and the treatment of the oxide surface by finely-divided carbon.

It will also be appreciated that while I have described my invention as applied to oxidized copper rectifying discs that it is applicable to uni-laterally conducting units comprising oxides of other metals than copper or other compounds of the metals than oxides. While I have described the principles of my invention as applied to particular embodiments herein, it will be understood that they are of broader application and that other methods of employing them will be readily apparent to persons skilled in the art. I, therefore, desire that the following claims be given the broadest interpretation of which their terms are susceptible in view of the limitations imposed by the prior art.

I claim as my invention:

1. In a method of preparing a contact rectifier, the steps of moving an oxidized metallic surface relative to a porous insulator impregnated with an electrolyte, and passing an electric current through the contact surface from said porous insulation, to the oxide layer.

2. In a method of preparing an electrical conductor having a uni-lateral electrical conductivity, the steps of moving an oxidized metallic surface relative to a porous insulator impregnated with an electrolyte and passing an electric current through the contact surface between the oxide and the porous insulator with the oxide electronegative.

3. In a method of preparing a uni-lateral electrical conductor, the steps of rapidly moving an oxidized metallic surface relative to a porous insulator impregnated with an electrolyte and passing an electric current through the contact surface from said porous insulator to said oxidized metallic surface.

4. In a method of preparing a circuit element having a uni-lateral electrical conductivity, the steps of moving an oxidized copper surface relative to a porous insulator impregnated with an electrolyte and passing electric current through the contact surface from said porous insulator to said oxidized copper surface.

5. In a method of preparing an oxidized copper rectifier, the steps of moving an oxidized copper surface relative to a porous in-

ulator impregnated with an electrolyte and passing electric current through the contact surface between said oxide and said porous insulator with the oxide electronegative.

6. In a method of preparing an oxidized copper rectifier, the steps of rapidly moving an oxidized copper surface relative to a porous insulator impregnated with electrolyte and passing electric current through the contact surface from said porous insulator to said oxidized copper surface.

7. In a method of preparing an oxidized copper rectifier, the steps of moving an oxidized copper surface relative to an impressionable porous insulator impregnated with electrolyte, and passing an electric current through the contact surface from said porous insulator to said oxidized copper surface.

8. In a method of preparing an oxidized copper rectifier, the steps of moving an oxidized copper surface relative to a porous insulator impregnated with electrolyte, and passing an electric current through the contact surface between said porous insulator and said oxidized copper surface at such current density as to evaporate said electrolyte before it has time to penetrate through said oxide.

9. In a method of preparing an oxidized copper rectifier, the steps of coating an oxidized layer on a copper base with finely-divided carbon, moving said oxidized surface relative to a porous insulator impregnated with electrolyte, and passing an electric current through the contact surface between said porous insulator and said oxidized surface.

10. The method of preparing an oxidized copper rectifier which comprises applying a thin layer of electrolyte to the oxidized surface of the copper rectifier, immediately thereafter passing a current through said electrolyte to the oxidized surface of the copper oxide rectifier and then immediately evaporating the remaining electrolyte.

11. The method of preparing an oxidized copper rectifier which comprises applying a thin layer of electrolyte to the oxidized surface of the copper rectifier, immediately thereafter passing a current through said electrolyte to the oxidized surface of the copper oxide rectifier and then immediately evaporating the remaining electrolyte before it has time to penetrate to the copper.

In testimony whereof, I have hereunto subscribed my name this 30th day of November, 1928.

HERBERT KAHLER.