June 27, 1933. P. H. DOWLING 1,915,984

MANUFACTURE OF COPPER OXIDE RECTIFIERS

Filed Jan. 28, 1933

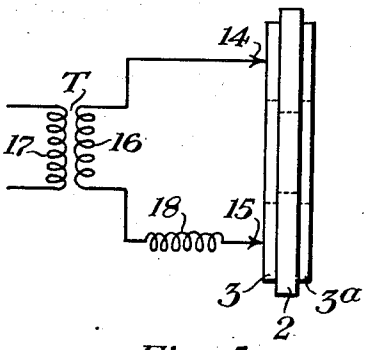


Fig. 5.

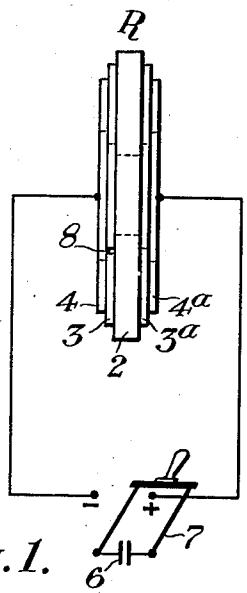


Fig. 1.

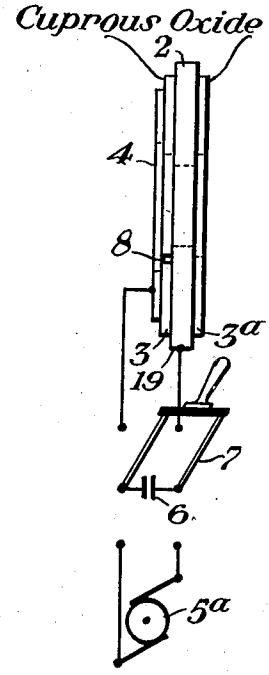


Fig. 2.

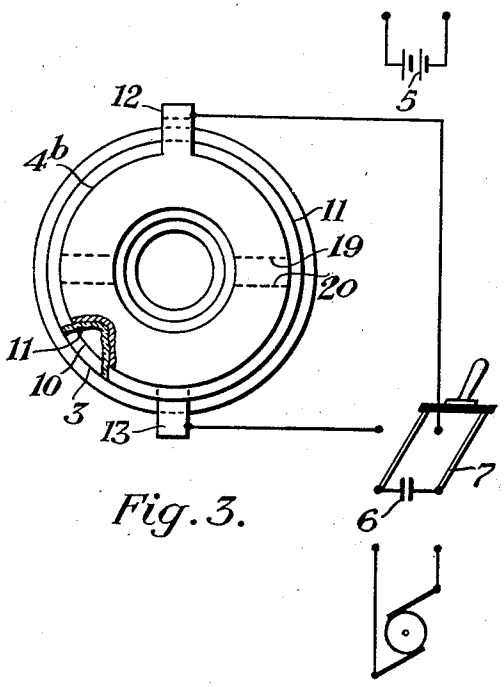


Fig. 3.

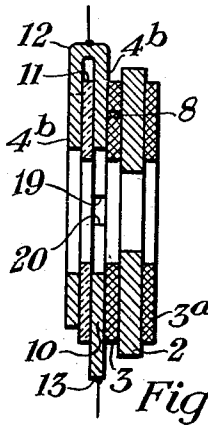


Fig. 4.

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UNITED STATES PATENT OFFICE

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MANUFACTURE OF COPPER OXIDE RECTIFIERS

Application filed January 28, 1933. Serial No. 654,010.

My invention relates to copper oxide rectifiers, and has for an object the novel and improved method of manufacturing rectifiers of this type.

I will describe several methods of manufacturing copper oxide rectifiers embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawing, Fig. 1 is a diagrammatic view illustrating one step in a process embodying my invention. Fig. 2 is a diagrammatic view illustrating the same step in a process embodying my invention, but wherein the breakdown discharge current does not pass through the junction which is subsequently to be used as a rectifying junction. Fig. 3 is a plan view, and Fig. 4 is a sectional view diagrammatically illustrating the step in the process embodying my invention wherewith the passing of the breakdown discharge current through the junction, which is subsequently to be used for rectifying, is also avoided. Fig. 5 is a diagrammatic view illustrating a method for preparing the rectifier for the step in the process embodying my invention. In each of the several views similar reference characters designate similar parts.

In accordance with my invention, a copper disk is first treated to form cuprous oxide on both sides and the cupric oxide which appears on the outer surface of the cuprous oxide is then removed by any desired means. Referring to Fig. 1, the device then appears as indicated at R, where 2 is the copper disk, and 3 and 3ª are the layers of cuprous oxide on the two sides of the disk, respectively. The reference characters 4 and 4ª represent lead washers contacting with the oxide layers 3 and 3ª, respectively.

5 is a source of direct current, which should be of from 200 to 300 volts for the treatment of a rectifier consisting of a single quenched disk, although this voltage range may be radically varied for different types of rectifier disks. A condenser 6 may be connected either with the source 5 or with the two lead washers 4 and 4ª by means of a double throw double pole switch 7.

The method of operating the apparatus shown in Fig. 1 is as follows: The switch 7 is first thrown downwardly to connect condenser 6 with the source 5, thereby charging the condenser. The switch 7 is then reversed, so that the condenser discharges through the rectifier R. When the polarity is as indicated in the drawing, the discharge current from the condenser flows through the left-hand rectifying junction, that is, the junction between the disk 2 and the oxide layer 3, in the high resistance direction, and the voltage is such as to break down this junction at one or more points, as indicated at 8. This discharge current flows through the right-hand junction, that is, the junction between disk 2 and oxide layer 3ª, in the low resistance direction, leaving this junction unharmed.

For the breakdown of a quenched rectifier disk 1½ inches in diameter, the condenser 6 may be of the order of 50 to 100 microfarads, although this range of capacities may be radically changed to meet the requirements of the specific disks under treatment. I have found that the conducting path formed by the breakdown of the rectifier junction has a resistance of approximately 0.0006 of an ohm.

Referring to Fig. 2, the metal washer 4ª is omitted and contact is made directly with the copper disk 2 as indicated at 19 in any convenient manner. This direct connection with the copper disk makes it unnecessary to pass the breakdown discharge current through the junction between the copper disk 2 and the oxide layer 3ª, which junction is subsequently to be used for rectifying. The process of charging the condenser 6 from the current source 5ª and then reversing the switch 7 to discharge the condenser 6 through the contact washer 4, oxide layer 3 and copper disk 2 to break down the oxide layer on that side of the disk at one or more points as indicated at 8 is similar to that described for Fig. 1. In this method of carrying out the process embodying my invention the breakdown discharge current may pass through the junction of the oxide layer 3 and the copper disk 2 in the low resistance direction as well as in the high resistance direction should it seem desirable to do so. I

have not found, however, that any particular advantage is obtained by breaking down the junction in the low resistance direction. In either case the voltage is such as to break down the junction between the disk 2 and the oxide layer 3 at one or more points as indicated by the reference character 8.

Another method to avoid passing the breakdown discharge current through the junction of the copper disk 2 and the oxide layer 3^a, which junction is subsequently to be used for rectifying, is shown in Figs. 3 and 4. In this form, three washers 4^b, 10 and 11 are used for contacting with the disk 2 on the side next to the junction to be broken down, the lead washer 4^b, which is to form the connection in the final rectifier, covers substantially the full area of the insulating washer 11 on the outside of that washer, and covers something less than one-half of the area on the side next to the oxide layer 3; while, the metal washer 10 covers something a little less than one-half of the area of the insulating washer 11 on the side next to the oxide layer 3. A tab 12 connects the two portions of washer 4^b, and a tab 13 is formed on the washer 10. These tabs 12 and 13 provide terminals for applying the breakdown discharge current to the two metal washers 4^b and 10. The polarity of the breakdown discharge current is immaterial, but a breakdown of the oxide layer 3 must occur under the washer 4^b as illustrated at 8 in Fig. 4. In this instance the path for the breakdown discharge current from the condenser 6 when the switch 7 is closed, is from one terminal of the condenser 6 through tab 12, metal washer 4^b, through oxide layer 3 into the copper disk 2, the copper disk 2 back through the oxide layer 3 to the metal washer 10, tab 13 and to the opposite terminal of the condenser 6, or vice versa, depending upon the polarity. In connection with this arrangement it is to be noted that washers 4^b and 10 are spaced with their adjacent edges 19 and 20 far enough apart so that the path through the copper disk 2 is the preferential path for the breakdown discharge current rather than directly through the oxide layer 3.

I have found that in electrically breaking down the junction between the oxide layer 3 and the copper disk 2 in the process embodying my invention, it is preferable that the breakdown shall occur in the interior of the oxide layer rather than near the edge of the layer. The location of the breakdown may be established in the manner illustrated in Fig. 5. Contact is made on the oxide layer at two points 14 and 15 and these points 14 and 15 are momentarily connected to a source of relatively high voltage such for example as the secondary winding 16 of a transformer T, the primary winding 17 of which is connected to the convenient source of alternating current not shown. An impedance 18 is connected in the circuit to limit the current flow. A direct current source of relatively high potential may be used in the place of the transformer T if it seems desirable. I have found that 3000 volts of alternating current, and a series impedance of 12000 ohms will give satisfactory results. After such a voltage has been applied at the points 14 and 15, a subsequent condenser discharge applied between a metal washer 4 and the copper disk 2 by any of the methods described hereinbefore always results in the junction between the oxide layer 3 and the disk 2 breaking down in the locality of the points 14 and 15. The 3000 volt current leaves no visible evidence of its passage and does not completely break down the junction. It appears simply to weaken the junction locally so that the subsequent application of the breakdown discharge current from the condenser will break down the junction in the locality of points 14 and 15. In practice, the high voltage might very conveniently be applied automatically during the process of carbonizing the side of the disk which is later to be used as the rectifying junction.

In manufacturing rectifiers in accordance with my invention, two courses may be pursued. The oxide layer may be broken down before assembling and the disk may then be stored with the lead washers remaining on the side which is broken down, or the breaking down may be accomplished after the rectifiier has been assembled. In the former case it may be desirable to provide additional means for causing adhesion between the lead washer and the disk beyond that which is furnished by the sputtering of the lead into the break; this may be accomplished by providing small quantities of glue or wax between the lead washer and the disk, which material will be warmed during the breakdown process and so when subsequently cooled will assist in holding the lead washer against the oxide surface.

One advantage of a process embodying my invention is that the disks remain flat throughout the entire process of production, and another advantage is that when the disks are finished, they are uniform as to thickness. Still another advantage is that a low resistance contact is obtained with the lead washer and the copper disk. It is also believed that the aging of the finished rectifier is improved.

Although I have herein shown and described only certain methods for the process of manufacturing rectifiers embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. The method of manufacturing a copper

oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, and electrically breaking down the rectifying junction on one side of the disk but not on the other.

2. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, and applying across the two oxide surfaces a difference of electrical potential of sufficient value to break down the rectifying junction through which the current due to such potential difference flows in the high resistance direction, leaving the rectifying junction on the other side of the disk unharmed.

3. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, and breaking down the rectifying junction on only one side of said disk by passing current therethrough in the high resistance direction.

4. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, and then applying across one of the oxide surfaces and the copper disk a difference of electrical potential of sufficient value to electrically break down the rectifying junction on the one side of the copper disk, leaving the rectifying junction on the other side unmolested.

5. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, placing two metal contacting washers on one side each covering only a portion of the cuprous oxide layer, and then applying across the two metal contacting washers a difference of electrical potential of sufficient value to electrically break down the rectifying junction between at least one of said washers and the copper disk, leaving the rectifying junction on the other side of the copper disk unmolested.

6. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, momentarily passing current between two spaced points on one side of the disk to weaken the junction locally at said two points, and then applying across the oxide layer on said one side and the copper disk a difference of electrical potential of sufficient value to electrically break down the rectifying junction locally weakened at said two points, leaving the rectifying junction on the other side of the disk unmolested.

7. The method of manufacturing a copper oxide rectifier which consists in forming cuprous oxide on both sides of a copper disk, placing a metal contacting washer on one side of the disk, and then applying across the metal washer and said disk a difference of electrical potential of sufficient value to electrically break down the rectifying junction on that side of the disk to form a low resistance path for current in either direction between the contacting washer and the disk.

In testimony whereof I affix my signature.

PHILIP H. DOWLING.