

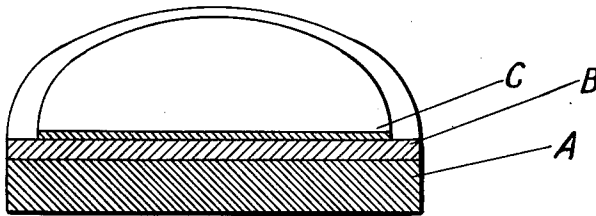
April 25, 1933.

J. G. H. LIEBEL ET AL

1,905,724

ELECTRIC CURRENT VALVE

Original Filed Aug. 8, 1927



INVENTOR.
John G. H. Liebel
and *Robert C. Jacquet*
BY *Allen + Allen*

ATTORNEY.

UNITED STATES PATENT OFFICE

JOHN G. H. LIEBEL, OF CINCINNATI, AND ROBERT C. JACQUELET, OF NORWOOD, OHIO,
ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE UNION SWITCH & SIGNAL COMPANY,
A CORPORATION OF PENNSYLVANIA

ELECTRIC CURRENT VALVE

Application filed August 8, 1927, Serial No. 211,629. Renewed February 4, 1933.

This invention relates to copper oxide valves or rectifiers for electric currents. These rectifiers are made by heating copper elements such as plates or discs to a high temperature, such as 1900° F. in the presence of oxygen and permitting films of copper oxide including red copper oxide to form on the copper member. The outside of this copper oxide film is then reduced to copper by contact with hydrogen or other reducing gases, or at appropriate temperatures with a reducing liquid, such as transformer oil, alcohol or glycerine or by other reducing means. A five to fifteen per cent water solution of alcohol is usually adequate to accomplish the desired reduction at 1000 to 1300 degrees of Fahrenheit.

The quenching of these elements in a liquid at a temperature such as 1000° to 1500° F. reduces the resistance of the elements and it is therefore recommended that the reduction and quenching be accomplished in the same step.

The object of this invention is to decrease the electrical resistance in the direction of useful current flow of copper oxide valves comprising a copper member or element having a film of copper oxide formed thereon and a layer of reduced copper on the surface of the copper oxide film.

Another object of the invention is to provide valve elements of the nature disclosed which will be possessed of more stable rectifying characteristics in service and which will decrease in output to a lesser extent than pre-existing valves of this type.

Reference is hereby made to the drawing in which the body of the copper plate is indicated at A, the coating thereon of copper oxide at B and the superficial coating of reduced copper at C.

The lessening of the resistance is accomplished by pressing the grains of reduced copper so that they form better contact with the copper oxide beneath and with one another. To accomplish this result, pressure or force is applied to the reduced surface of the elements, thereby uniting the grains into better mutual contact, said pressure or force being applied preferably in two direc-

tions in relation to the reduced surface of the plate; namely, at right angles to the surface and transversely thereto. Rubbing or burnishing the surface to brightness with fine crocus cloth or a rag polishing wheel produces this reduction in resistance admirably. In this burnishing operation care must be used not to heat the plate excessively.

The difference of the resistance in the useful direction between burnished and unburnished elements approaches one hundred per cent, that is, the resistance of an unburnished element is approximately cut in half by the burnishing operation. Although the results vary somewhat with each individual element, the burnishing process also tends materially to standardize production and provides plates of greater uniformity.

A further advantage of the above described process is that the valves produced have more stable rectifying characteristics in service and decrease in output to a lesser extent than unburnished valves.

It is also preferable to etch the edges of these plates with acid such as nitric acid to remove the reduced copper and avoid short circuiting of the plates about the edges.

Having described our invention, we wish to be limited only by the ensuing claims:

1. An electric current valve, comprising, a copper member having a film of copper oxide thereon, and a layer of reduced copper on the surface of the oxide film, the surface of said layer burnished.

2. The process of making an electric current valve, comprising, the heating of a copper member to a temperature approximating 1900° F. in the presence of oxygen, the reduction of the surface of the oxide film by contact with a reducing liquid when said copper member is at an elevated temperature, and the pressing of the grains of the reduced copper into a smooth surface to decrease the electric resistance of the element.

3. The process of lowering the electrical resistance in a useful direction of current valves of the copper oxide type having reduced copper surfaces, said process, com-

prising, the application of force to said reduced surfaces both at right angles and transversely thereto.

4. An electric current valve comprising a copper member having a film of oxide thereon, and a layer of reduced copper on the surface of the oxide film, the contacting surfaces of the copper oxide layer and the reduced copper oxide consolidated by burnishing.

5. An electric current valve comprising a copper member having a film of copper oxide thereon, and a layer of reduced copper on the surface of the oxide film, the film and layer consolidated by an application of force both at right angles and transversely thereto.

6. A process of making an electric current valve comprising heating a copper member to a temperature approximating 1900° Fahrenheit in the presence of oxygen, the reduction of the surface of the oxide film by contact with a reducing liquid when said copper member is at an elevated temperature, whereby a layer of elemental copper is formed upon said oxide film, and burnishing said layer of elemental copper.

7. A process of making an electric current valve comprising heating a copper member to a temperature approximating 1900° Fahrenheit in the presence of oxygen, the reduction of the surface of the oxide film by contact with a reducing liquid when said copper member is at an elevated temperature, whereby a layer of elemental copper is formed upon said oxide film, and pressing said layer of elemental copper into contact with said film by force applied both at right angles and transversely thereto.

8. The process of making an electric current valve which comprises forming on the surface of a copper member a film of copper oxide, reducing the surface of said film to form a layer of elemental copper thereon and subjecting said layer of elemental copper to a pressure rubbing operation.

9. A rectifier for alternating electric current comprising a metallic mass consisting principally of copper and having an oxidized surface which latter has been reduced to a metallic form on its exposed surface, said reduced surface being consolidated by rubbing with material pressure.

10. The process of producing a rectifier for alternating electric current which consists in coating one face of a mass consisting principally of copper with rectifying oxide, reducing the outer face of said oxide, and consolidating the metallic film thus produced by rubbing with material pressure.

11. The process of producing a rectifier for alternating electric current from a plate consisting principally of copper which consists in heating the same, exposing it in the air, quenching it in a reducing bath and con-

solidating the metallic film thus produced by rubbing with material pressure.

In witness whereof, we hereunto subscribe our names.

JOHN G. H. LIEBEL.
ROB. C. JACQUELET.

70

75

80

85

90

95

100

105

110

115

120

125

130