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RECTIFIER AND METHOD FOR PRODUCING THE SAME

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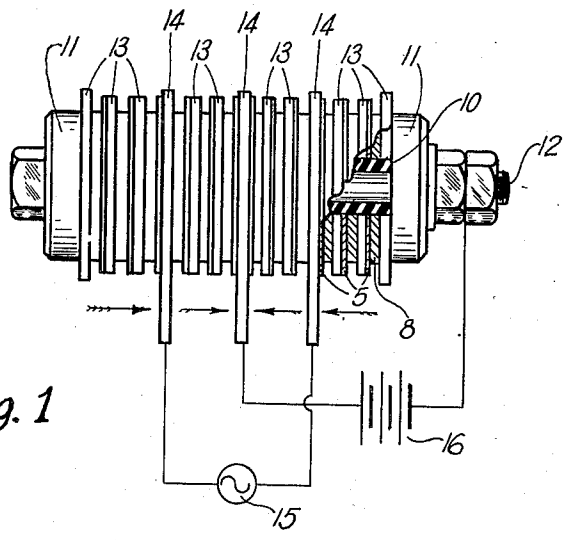


Fig. 1

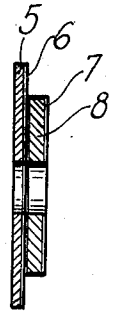


Fig. 2

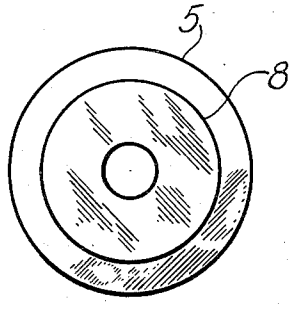


Fig. 3

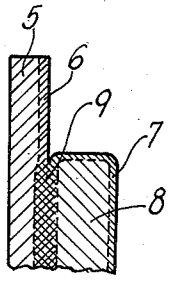


Fig. 4

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RECTIFIER AND METHOD FOR PRODUCING THE SAME

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11 Claims. (Cl. 175—366)

My invention relates to devices for rectifying alternating electric current and more particularly to improvements in that type of rectifier which obtains unilateral current conduction by virtue of the dry surface engagement of certain electropositive and electronegative substances.

The present invention constitutes an improvement in dry contact rectifiers of the type described and claimed in application for U. S. Letters Patent, Serial No. 683,713, filed August 4, 1933 by Carl Hambuechen. Such rectifiers employ couples or cells, each comprising a copper sulfide element and an element of magnesium, aluminum or other suitable electropositive metal.

An object of my invention is to improve the efficiency, durability and stability of copper sulfide rectifiers; to produce an improved unilateral current conducting junction between the elements of the couples which is capable of functioning more efficiently and for longer periods of service than has been heretofore possible in rectifiers of similar kind.

Another object of my invention is to produce so-called copper sulfide rectifiers which function satisfactorily at relatively high voltage, or such voltage as would injure and render inoperative dry contact rectifiers constructed by heretofore prevailing methods.

It has been determined that rectifiers of the type herein concerned are subject to impairment by extended periods of idleness; that when initially placed in service, or returned to service following a substantial non-operating period, they exhibit the unfavorable characteristic of electrical instability or fluctuating output, and pass abnormal leakage current which results in poor efficiency. These conditions may be of short duration or may persist indefinitely unless special steps are taken to remedy the same. In most instances the impairment resulting indirectly from idleness can be remedied by subjecting the rectifier to voltage, for a short period of time, considerably higher than the normal operating voltage of the device. This process, it is believed, reforms the rectifying junction between the electropositive and electronegative elements.

An important object of my invention is to provide a rectifier which is not affected by periods of idleness, and accordingly which does not require special treatment by the user to restore the device to normal and proper operating efficiency.

In the accompanying drawing illustrating the present invention, Fig. 1 is a partially sectioned side view of a rectifier, with connections (shown schematically), adapted for effecting full wave rectification; Fig. 2 is a cross-sectional view of a rectifying couple as the same appears prior to the "forming" operation; Fig. 3 is a plan view of a rectifying couple, and Fig. 4 is an enlarged, fragmentary cross-sectional view of a couple after the "forming" operation.

I have discovered that the operating characteristics of copper sulfide rectifiers may be enhanced and the foregoing objects and improvements attained by the presence of phosphorus, or the products of reaction of phosphorus with the electropositive and electronegative substances comprising the elements of the couples, in the rectifying composition formed between the elements. The presently preferred manner of introducing phosphorus into the couples, and method for producing my improved rectifier is hereinafter described.

Electronegative elements are produced in a shallow pan containing a mixture of finely divided sulphur and an inert material, for example, comminuted pumice. Copper washers of the desired dimensions are placed on this mixture and the pan and its contents heated until the copper reacts with the sulphur to form copper sulfide. The inert material, above referred to, provides a convenient support for the washers during the described sulfiding process, and being of a heat insulating nature assists in maintaining an even distribution of heat about the washers. This prevents warping and distortion and results in discs which are substantially uniform in shape and homogenous throughout. The washers thus produced may be given additional mechanical strength by again applying heat to render them plastic and subjecting them to pressure while in that condition.

The copper sulfide washers are next immersed in a solution or suspension of yellow or red phosphorus in carbon bisulfide or other suitable solvent or liquid vehicle. Immersion of the washers for five minutes in a solution containing 12 grams of yellow phosphorus in 100 cc. of carbon bisulfide will produce a satisfactory phosphorus coating, but the use of a more concentrated solution or a longer immersion period has been found to yield a superior product. The washers are removed from the solution and when reaction between the copper sulfide and phosphorus has been completed, or the latter oxidized to phosphoric anhydride, and excessive phosphoric acid removed by a water rinse, the electronegative elements thus produced are ready to be coupled with the electropositive elements.

The phosphorus treated copper sulfide wash-

ers above described, when coupled with elements formed from any of a number of the lighter electropositive metals have been found to result in rectifiers having improved operating characteristics. Elements of aluminum, zinc and magnesium have been successfully used. The best results have been obtained by utilizing washers of magnesium containing a small percentage of manganese, treated to have produced on one side thereof, a thin layer of precipitated or electrodeposited manganese. The electropositive elements may be desirably produced by the following method. One side only of a sheet of metal from which the elements are to be produced is rubbed down or polished with dry powdered pumice to remove any grease or oxide film. The sheet is then immersed in a solution containing a manganese salt, for example, manganese chloride, whereupon a relatively thin black coating of manganese forms on the rubbed surface. Practically no manganese is precipitated on the unrubbed surface. The sheet is removed from the solution, dried, and washers are punched therefrom.

The electropositive and electronegative elements heretofore described are assembled in the following manner to produce rectifying couples or cells. Assuming that electropositive elements of the manganese coated type are utilized, the manganese coating is placed in contact with a phosphorus treated copper sulfide element and the elements are forced together under pressure, preferably upward of 500 pounds per square inch. While so compressed, current is passed through the couple causing the contacting surface portions of the individual elements to react, electrothermically, to produce an intermediate rectifying material which effectually welds the elements together.

Rectifying couples prepared by the method described may be grouped in any of the well known assembly arrangements to produce half-wave or full-wave rectifying units. In the accompanying drawing, Fig. 1 illustrates a unit, the rectifying couples of which are assembled in accordance with the so-called Gratz, or bridge system to give full wave rectification.

The couples are shown assembled on a tube 10 of insulating material and clamped together between end plates 11 by a bolt 12 extending axially through the assembly. The couples, separated by brass or other suitable washers 13, are arranged in four groups or sections divided by three terminal plates 14, the couples being oriented to allow current to pass through the groups in the direction shown by arrows. A generator 15, and a battery 16, illustrated schematically, are shown in circuit relation with the unit as the same might be used for battery charging purposes.

Fig. 2 is a sectional view of a couple as it appears prior to the electrical forming operation above described, numeral 5 indicating the electropositive washer, and 6 designating the layer of precipitated or electro-deposited manganese on the inner face of element 5. The manganese layer is shown to be in contacting adjacence with the phosphorus treated surface 7 of the copper sulfide element 8.

Fig. 3 is a plan view of the couple appearing in Fig. 2.

Fig. 4 is an enlarged fragmentary sectional view of the couple following completion of the electrical forming process. Heat resulting from the electric current which passes across the inter-engaging surfaces of the compressed elements reduces the adjacent materials to a plastic state, causing them to react and merge physically. The composition comprising the products of this reaction is indicated at 9, Fig. 4.

Having fully described my improved rectifier and process for making the same, I claim:

1. In a dry contact rectifier, a copper sulfide element having a pre-formed coating of phosphorus, united with an element of one of the lighter electro-positive metals.

2. In a dry contact rectifier, a copper sulfide element having a pre-formed coating of phosphorus, united with a magnesium element.

3. In a dry contact rectifier, a copper sulfide element having a pre-formed coating of phosphorus, united with an element of magnesium-manganese alloy.

4. In a dry contact rectifier, a copper sulfide element having a pre-formed coating of phosphorus, united with a magnesium element having a pre-formed coating of manganese.

5. In a dry contact rectifier, a couple comprising a phosphorus-treated copper sulfide element welded to a magnesium element.

6. In a dry contact rectifier, a couple comprising a phosphorus-treated copper sulfide element, and a magnesium element having a thin coating of manganese, said elements being electrically welded together.

7. The method of making dry contact rectifiers which comprises forming a phosphorus coating on a copper sulfide element, placing an electro-positive metal element in contact with said phosphorus coating and passing current through the couple to cause electro-thermic reaction between the said materials.

8. The method of making dry contact rectifiers which comprises forming a phosphorus coating on a copper sulfide element, placing an electropositive metal element in pressure engagement with said phosphorus coated element and passing current through the elements to cause electro-thermic reaction between the said materials.

9. The method of making dry contact rectifiers which comprises applying a phosphorus solution to a copper sulfide element, drying the element, placing said treated element in pressure engagement with an electro-positive metal element and passing sufficient current through said elements to plasticize the adjacent surface portions of said elements.

10. The method of making dry contact rectifiers which comprises immersing a copper sulfide element in a phosphorus solution, drying the element to remove the solvent, forming a thin coating of manganese on a magnesium element, contacting the phosphorus treated copper sulfide element with the manganese coating of the magnesium element and passing current through the couple to weld the elements together.

11. The method of making dry contact rectifiers which comprises forming, by precipitation, a thin manganese coating on one side surface of a magnesium element; treating a copper sulfide element with a phosphorus solution to produce a thin coating of phosphorus thereon, disposing the coated surfaces of said elements in contacting adjacence, forcing the elements together under pressure, and passing current through the compressed elements to weld the same together.

CARL E. PETERS.