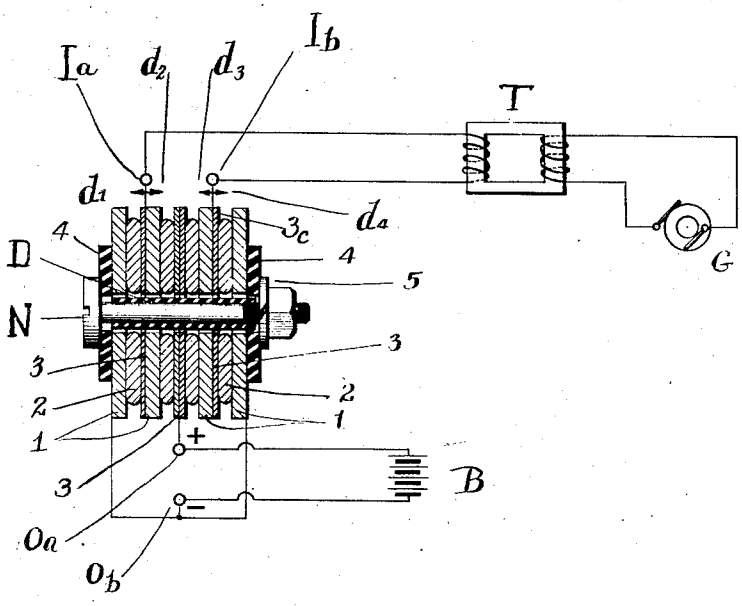
Nov. 15, 1927. 1,649,743

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ELECTRIC CURRENT RECTIFIER

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UNITED STATES PATENT OFFICE.

SAMUEL RUBEN, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO RUBEN RECTIFIER CORPORATION OF DELAWARE.

ELECTRIC-CURRENT RECTIFIER.

Application filed January 2, 1925. Serial No. 155.

This invention relates to electric current rectifiers and the like and particularly to electrode elements which are adapted to provide an asymmetric couple of the dry surface contact variety.

The object generally of the invention is to provide a device of this character which is economical, efficient and readily manufactured.

More specifically, an object of the invention is to provide an arrangement of electrode elements which is adapted for high duty service in rectification and the like when one of the elements has a particular composition, or specifically, when the electropositive element is made of a substantially non-oxidizable compound.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts, which will be exemplified in the constructions hereinafter set forth and the scope of the application of which will be indicated in the claims.

The present application is a continuation in part of my prior and co-pending application, Serial No. 750,539, filed November 18, 1924.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which the figure is a view showing, partly diagrammatically and partly in section, a rectifying device constructed in accordance with the present invention arranged for battery-charging service.

In the practice of the present invention a dry surface-contact rectifying device is provided, having as one electrode a substantially non-oxidizing aluminum compound, such as aluminum and mercury, aluminum and magnesium, or aluminum, magnesium and mercury, in surface contact with a cooperating electrode composed of a material which is also substantially non-oxidizing at operating conditions or temperatures, such as silver sulphide, or with an oxidizable electronegative material, such as cupric sulphide or both, suitable precautions being taken to prevent the formation of oxides at the contacting areas, when an oxidizable material is so employed. Rectification in this unit, as in that described in my said prior application, is effected through unilateral conduction; that is, current flows through the unit only when the electropositive aluminum compound electrode is negatively charged, and will not flow when that element functions as the anode in the circuit. The probable resultant effect of the reaction between the aluminum electrode and the sulphide electrode is the formation of an aluminum sulphide film.

When current of excessively high densities is applied to the rectifying unit described in my said prior application, the effect of the heat developed thereby at the juncture of the electrodes is to produce a cuprous oxide coating upon the contacting surfaces. This occurs, however, only when the heat resulting from such a discharge is sufficient to cause that reaction. With the continued application of such a current, this action goes on over the entire contacting areas, until the increased electrical resistance developed by this product of the reaction, materially lowers the efficiency of the unit.

This reaction can be substantially completely avoided by using, as the electrode in combination and in surface contact with the aluminum compound electrode, a sulphide compound which will not form an oxide, or which by the intimacy of contact, can not oxidize over the contacting areas, and which will permit continuous operation of the couple at relatively high current densities.

Silver sulphide, as a non-oxidizing compound, is well adapted to this use, applied to the surface as a coating of the aluminum electrode, applied in any suitable manner, as in solution with a binder, or as a thin contacting plate. Likewise, cupric sulphide is well adapted to this use, but, best when employed as an electrode coating applied as a fine powder in solution with an inert binder, such as gum arabic; a combination of both of these materials, mixed and so applied, has certain advantages, in that the relatively high resistance of the silver sulphide element is counter-balanced by the relatively low resistance of the cupric sulphide, which latter readily gives up its sulphur to the silver metal should the silver sulphide lose its sulphur element through vaporization of that element, due to excessive heat, or otherwise, reestablishing the sil-

ver sulphide coating area. Due to the close surface contact of the cupric sulphide with the aluminum electrode, no air can reach that area, and hence no cuprous oxide can be formed thereby. The cupric sulphide sulphur supplying element can also be supplied by the employment of a coating of this material upon a conductive material, in close surface contact with the silver sulphide electrode.

For normal operating conditions, the silver sulphide electrode is satisfactory in its performance, without the use of any contacting sulphur bearing body. Employed as a coating a thickness of .1 millimeter is sufficient. By the employment of either sulphide electrode in the manner described, the production of any oxide in the area of the electrode junctures is avoided, as is also the building up of an electrical resistance in the operation of this type of rectifier.

The assembled rectifying unit is substantially unilaterally conductive or rectifying, without any necessity for first applying an inverse or formation current, its alternating current application being practically constant, and with no sparking between the electrodes.

Besides being adapted to alternating current rectification, such a couple is equally well adapted for other uses, such as a high capacity condenser and as an automatic direct current cut-off relay. As a cut-off relay, when the potential of a storage battery or other unit in a charging circuit, becomes higher than the potential of the generator, or charging source, the direct current supply is cut off, and there is no discharge from the storage battery to the source.

Referring now to the drawing, 1 represents a series of copper plates, 2 a series of cupric sulphide plates and 3 a series of aluminum mercury electrode plates, each in intimate contact with a coating of silver sulphide depicted at 3_c, which is disposed adjacent a cupric sulphide plate 2. At I_a and I_b are alternating current input leads, and at O_a and O_b are the rectified current output terminals. The positive pole of battery B is connected to the middle aluminum mercury electrodes 3, having their cooperating electrodes as coatings 3_c upon their surfaces adjacent the cupric sulphide plates 2, and the negative pole of battery B is connected to the copper end plates. Bolt N holds the various conductive plates and the electrodes 3 and 3_c, in close surface contact, it being insulated therefrom by fibre tube D and by insulating end washers 4. By this arrangement, the devices being charged can not discharge any measurable current through the rectifier. T is a step-down transformer for the reduction of potential for battery charging, and G is the generator supplying the input current. At 5 is a spring washer to insure constant pressure with temperature changes. As the alternating current is applied to the unit, current flows when the aluminum mercury electrode is the cathode, in the direction indicated by arrows d_1 and d_4; upon the reversal of polarity of the current, the current flows as indicated by arrows d_2 and d_3, rectifying the applied alternating current, and permitting the application of direct current to the output terminals O_a and O_b. The battery receives a charge when the output direct current potential is greater than its own; but, should this potential be reduced below that of the generator, the battery will not discharge in the opposite direction because of the practically open circuit resistance of the aluminum mercury electrode, when connnected as an anode.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In dry surface-contact rectifying devices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of a compound of aluminum and a composite electronegative electrode element having as one component a metallic sulphide, substantially resistant to electro-chemical oxidation.

2. In dry surface-contact rectifying devices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of a compound of aluminum, and an electronegative electrode element composed of an electrically conducting metallic silver sulphide and a cooperating layer of sulphide.

3. In dry surface-contact rectifying devices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of an amalgam containing aluminum and a composite electronegative electrode element containing a metallic sulphide adapted to resist electro-chemical oxidation.

4. In dry surface-contact rectifying devices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of an amalgam of an alloy of aluminum and an electronegative electrode element disposed and arranged to apply a non-oxidizable surface of silver sulphide in contact with said electropositive element.

5. In dry surface-contact rectifying devices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of a relatively highly electropositive metallic element and an electronegative electrode element composed of an electrically conducting metallic sulphide and an interposed layer of silver sulphide.

6. In dry surface-contact rectifying de-

vices and the like, an asymmetric electric couple comprising an electropositive electrode element composed of an aluminum compound, a coating of silver sulphide disposed in contact with said aluminum compound and an electronegative electrode component composed of an electrically conducting metallic sulphide cooperatively disposed against said silver sulphide.

7. A current rectifier of the type described, having a pair of electrodes, one of which is an aluminum compound, and the other of which is a composite body having a cooperating layer of silver sulphide between and in surface contact with said aluminum compound electrode, said body composed of a copper compound.

8. A current rectifier of the type described, having a pair of electrodes, one of which is an aluminum compound, and the other of which is silver sulphide between and in surface contact with said aluminum compound electrode and a body composed of cupric sulphide.

9. A current rectifier of the type described, having a pair of electrodes, one of which is an alloy of aluminum and mercury, and the other of which is silver sulphide between and in surface contact with said aluminum alloy electrode and a body composed of cupric sulphide.

10. A current rectifier of the type described, having a pair of electrodes, one of which is an electropositive material, and the other of which is a composite body having a cooperating layer of silver sulphide, said body composed of a copper compound, said silver sulphide coating being applied with a fluid binding material to the surface of said electropositive material.

11. A current rectifier of the type described, having a pair of electrodes, one of which is an electropositive material, and the other of which is a composite body having a cooperating layer of silver sulphide, said body composed of a copper compound, said silver sulphide coating being applied with a fluid binding material to the surface of said other electrode.

12. A current rectifier of the type described, having a pair of electrodes, one of which is an electropositive material, and the other of which contains silver sulphide and cupric sulphide.

13. A current rectifier of the type described, having a pair of electrodes, one of which is an electropositive material, and the other of which contains silver sulphide and cupric sulphide, said other electrode being applied as a coating upon a surface of said electro-positive electrode, as powder in solution with an inert binder.

14. A current rectifier of the type described, having a pair of electrodes, one of which is an electro-positive material, and the other of which contains silver sulphide and cupric sulphide, said other electrode being applied as a coating upon a surface of said electro-positive electrode, as powder in solution with an inert binder, said binder comprising gum arabic.

Signed at New York in the county of New York and State of New York this 8th day of December, A. D. 1924.

SAMUEL RUBEN.