Oct. 13, 1931. S. RUBEN 1,826,955

ELECTRIC CURRENT RECTIFIER

Filed March 30, 1927

Fig. 1.

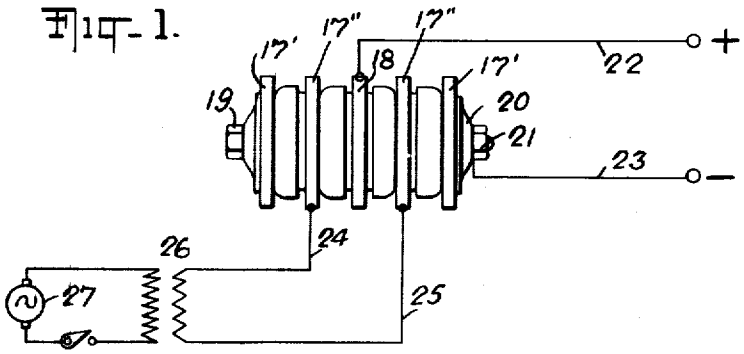


Fig. 2.

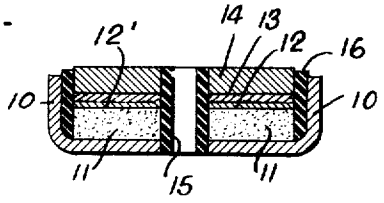


Fig. 3.

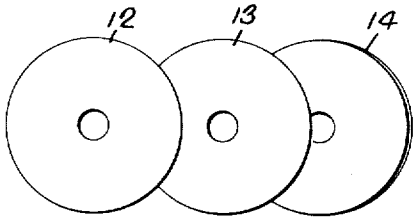
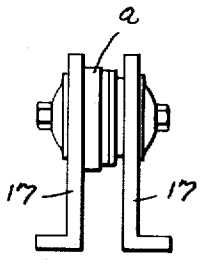


Fig. 4.



INVENTOR.
Samuel Ruben
BY
Mayer, Warfield & Watson
ATTORNEYS.

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UNITED STATES PATENT OFFICE

SAMUEL RUBEN, OF NEW YORK, N. Y., ASSIGNOR TO RUBEN RECTIFIER CORPORATION, OF ENGLEWOOD, NEW JERSEY, A CORPORATION OF DELAWARE

ELECTRIC CURRENT RECTIFIER

Application filed March 30, 1927. Serial No. 179,478.

This invention relates to electric current rectifiers and the like, which employ asymmetric couples of the dry surface-contact variety.

Rectifiers of this variety are known, which are characterized by the use of a body of relatively electropositive material, employed as one electrode element, disposed in electrical contact with a body of relatively electronegative material employed as the other electrode element; there being an intervening film having inverse current-blocking properties. Such rectifiers depend for their operation upon the resistance and current-blocking characteristics of the film which forms as the result of electrochemical action. Rectifiers depending on these characteristics known to the prior art, have been low in efficiency and limited in their application to small currents, because of improper conditions for film-formation and maintenance, and become substantially inoperative after short periods of use.

The invention has for its object generally to provide an improved device of the character specified, which is efficient, economical and readily manufactured, and has a relatively long operating life for high current-densities. To this end the electronegative electrode material here employed is preferably in powder form and selected to withstand the effects of electrolytic action.

A more specific object of the invention is to provide an asymmetric couple in which the electronegative electrode element has relatively high density and is also relatively conformable to the co-operating surface of the electropositive electrode element, so that there is substantially a maximum area at all times at the contacting surfaces of the electrode elements.

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.

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 drawings, in which:

Figure 1 shows diagrammatically a rectifying device constructed in accordance with the invention;

Fig. 2 is a cross-sectional view showing the arrangement of the electrode elements here employed;

Fig. 3 is an elevational view showing the form of the plate members employed in the asymmetric couple shown in Fig. 2; and

Fig. 4 is an elevational view showing a single asymmetric couple of the present invention mounted upon standards.

Referring now to the drawings and particularly to Fig. 2, 10 denotes a cup, or receptacle having upturned sides, which is made of suitable conducting material; for example, copper, brass or steel, in which is disposed a layer of material 11, here employed as the electronegative electrode element.

An electropositive electrode element is shown as a plate member, or disc 12, of suitable material disposed in co-operative contact above the layer of material 11. A second disc 13, adapted to serve as a backing, is disposed on the disc 12 and is here shown by double hatching. Any soft metal which will absorb vibration and compensate for excessive expansion-contraction of the elements, may be chosen as the component material for disc 13, for example, lead. Above the disc 13 is a third disc 14 designed as a closure for the cup 10 and is preferably of the same material as the cup 10.

When the asymmetric couples of the present invention are to be assembled by means of a bolt, the discs and cup 10 are perforated and have an insulating tube 15 passed therethrough. In order also that the electrical relation of the elements of the couple be not disturbed at the outer edge, an insulating collar 16 is inserted between the upstanding rim of the cup 10 and the edges of the discs.

The cup and the plate-members, thus assembled, comprise an asymmetric couple which affords a convenient unit from which

to build up a rectifying device of any convenient character; for example, as a four-couple device as shown in Fig. 1, or as a single-couple device, as shown in Fig. 4. In the latter a couple *a* is shown as disposed between conducting end-plates 17, formed to serve as standards.

In the device, illustrated in Fig. 1, two groups comprising two couples each, the couples being disposed between conducting end-plates 17′, are inverted with respect to each other, and disposed in conducting relation with the central terminal-plate 18. The clamping-bolt 19 extends through the assembled couples and has spring-washers 20 inserted between the terminal-plates 17′ and the head-ends of the bolt. By the arrangement shown, it is seen that the four couples here employed comprise the arms of a Wheatstone bridge, of which the terminals provided at 18 and 21 comprise one diagonal of the bridge circuit, and are adapted to serve as terminals for the output circuit of the rectifying device, here shown as conductors 22 and 23, leading to the terminals of a direct-current consuming device, here symbolically indicated by the signs + and −.

The terminal-plates 17″ disposed intermediately of the inverted groups are the terminals of the other diagonal of the bridge circuit and serve as terminals for the alternating-current input circuit, here shown as the conductors 24 and 25, leading from the low tension side of a suitable step-down transformer 26, which is here shown as connected to an original source 27 of alternating current; for example, a commercial 60-cycle, 110-volt, AC-supply.

By the arrangement shown, when the conductor 24 has a plus polarity, the electronegative electrode element in the cup 10 adjacent to the terminal-plate 17″ to which the conductor 24 leads, will be positively charged and a direct current will pass, as a result of rectification, to the plate 18, and thence by way of the conductor 22 to the plus terminal of the direct-current consuming device, and from thence by way of conductor 23 and a second electronegative electrode element adjacent to the terminal 21 to the conductor 25; and vice versa when the conductor 25 has a plus polarity.

The electropositive electrode element here employed is a metallic body in solid form of substantially any relative stable but highly chemically active electropositive element, for example, aluminum, boron, calcium, magnesium or zinc, such as taught in my co-pending application Serial No. 69,215, filed November 16, 1925.

The electronegative electrode element is a body preferably in powdered form, of a relatively highly electronegative chemical element in a relatively pure state. In the arrangement shown at 11, in Fig. 2, a body of powder which is relatively highly compressed, is disposed in the bottom of the cup 10. The chemical elements adapted to be components of the electronegative electrode elements are preferably the elements of the sixth group of chemical elements in the periodic table, which have relatively high electrical conductivities and are adapted also to react strongly in forming an inverse current-blocking film at the contacting surface between the electropositive and electronegative elements. Suitable chemical elements have been ascertained to be selenium and tellurium.

In order that there may be a sufficient energy for the reaction of electrochemically forming and maintaining the inverse current-blocking film supplied out of the resistance losses incident to the passage of rectifying current through the asymmetric couple, as set forth in my co-pending applications Serial No. 38,781, filed June 20, 1925, and Serial No. 113,009, filed June 1, 1926, a resistance layer is provided at the contacting surface between the electropositive and electronegative electrode elements. Such layer may be a thin coating of an oxide 12′ disposed over the contacting surface of the disc 12 and is placed in contact with the electronegative element 11. Where the disc is of magnesium and the electronegative electrode element is powdered tellurium having an effective contacting surface of substantially one square inch, a uniform layer of .0001 of an inch in thickness of magnesium oxide on the magnesium disc is sufficient for the practice of the present invention. The pressure to be applied to the couple, as set forth in my application Serial No. 38,781, should be sufficent to prevent the inverse current-blocking film for being disrupted by electrostatic repulsive forces operating at the contacting surfaces.

Where the electronegative electrode element is in powder form, it is adapted to adjust itself for intimate contact with the electropositive electrode element under substantially all conditions of operation and is, therefore, adapted for operation at substantially maximum current densities. It has been ascertained that in asymmetric couples of this character in which the contacting surface has been electrolytically oxidized to provide a relatively rigid contacting resistance layer, a couple is produced capable of resisting the effects of the composition by electrolysis, and in consequence has a high stability characteristic and is adapted for service under severe operating devices over relatively long periods of time.

In a service, however, where compactness is more important than high current density, an electronegative electrode element of the character here employed can still be made use of by casting the same into a solid disc and assembling the rectifier, as taught in my co-

pending application Serial No. 750,939, filed November 18, 1924.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

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 couple having an electronegative electrode element of metallic tellurium, and an electropositive electrode element of a relative stable highly chemically active electropositive metal formed to have a contact resistance adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

2. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium, and an electropositive electrode element of a relatively stable highly chemically active electropositive metal formed to have a contact resistance adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface, means in contact with said electropositive electrode element for absorbing the energy of vibration in said couple, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

3. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium, and an electropositive electrode element of a solid body of metallic magnesium formed to have a resistance layer over its contacting surface adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

4. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium, and an electropositive electrode element of a solid body of metallic magnesium formed to have a resistance layer of magnesium oxide uniformly disposed over its contacting surface adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface, means in contact with said electropositive electrode element for absorbing the energy of vibration in said couple, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

5. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium in powder form, a conducting cup adapted to support the same, an electropositive electrode in plate form of a relatively stable highly chemically active electropositive metal disposed in said cup in contact with said powder element and formed to have a contact resistance adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contact surface, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

6. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium in powder form, a conducting cup adapted to support the same, an electropositive electrode in plate form of a relatively stable highly chemically active electropositive metal disposed in said cup in contact with said powder element and formed to have a contact resistance adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface; a second plate of soft metal disposed in said cup upon said electropositive electrode plate, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

7. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metallic tellurium in powder form; a conducting cup adapted to support the same, an electropositive electrode in plate form of a relatively stable highly chemically active electropositive metal disposed in said cup in contact with said powder element and formed to have a contact resistance adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface; a second plate of soft metal disposed in said cup upon said electropositive electrode plate; a third plate of conducting material similar to said cup disposed upon said second plate and arranged to serve as a closure for said cup, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

8. In dry surface-contact rectifying devices and the like, an asymmetric couple having an electronegative electrode element of metal-

lic tellurium in powder form; a conducting cup adapted to support the same; an electropositive electrode element of a solid body of metallic magnesium formed to have a resistance layer of magnesium oxide uniformly disposed over its contacting surface adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface; a second plate of soft metal disposed in said cup upon said electropositive electrode plate; a third plate of conducting material similar to said cup, disposed upon said second plate and arranged to serve as a closure for said cup, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

9. A dry surface-contact rectifying device including an anode of tellurium and a cathode of a relatively highly electropositive metal.

10. A dry surface-contact rectifying device including an anode of tellurium and a cathode of magnesium.

11. A dry surface-contact rectifying device comprising an anode of tellurium and a cathode of a relatively highly electropositive metal and an oxide layer therebetween.

12. A dry surface-contact rectifying device comprising an anode of tellurium and a cathode of magnesium and an oxide layer therebetween.

In testimony whereof I affix my signature.

SAMUEL RUBEN.

lic tellurium in powder form; a conducting cup adapted to support the same; an electropositive electrode element of a solid body of metallic magnesium formed to have a resistance layer of magnesium oxide uniformly disposed over its contacting surface adapted to supply the energy from resistance losses for the formation and maintenance of an inverse current-blocking film at the contacting surface; a second plate of soft metal disposed in said cup upon said electropositive electrode plate; a third plate of conducting material similar to said cup, disposed upon said second plate and arranged to serve as a closure for said cup, and means for maintaining said couple assembled under pressure sufficient for a relatively permanent rectifying effect.

9. A dry surface-contact rectifying device including an anode of tellurium and a cathode of a relatively highly electropositive metal.

10. A dry surface-contact rectifying device including an anode of tellurium and a cathode of magnesium.

11. A dry surface-contact rectifying device comprising an anode of tellurium and a cathode of a relatively highly electropositive metal and an oxide layer therebetween.

12. A dry surface-contact rectifying device comprising an anode of tellurium and a cathode of magnesium and an oxide layer therebetween.

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CERTIFICATE OF CORRECTION.

Patent No. 1,826,955. **Granted October 13, 1931, to**

SAMUEL RUBEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 105, for "for" read from; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of February, A. D. 1932.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

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