

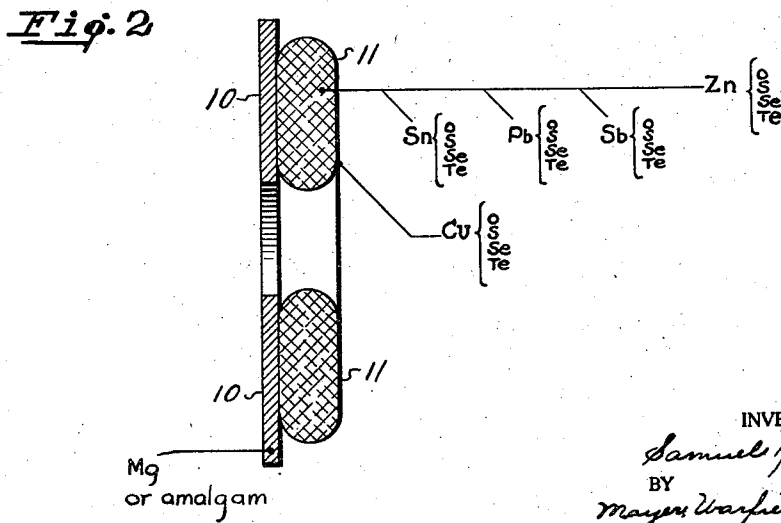
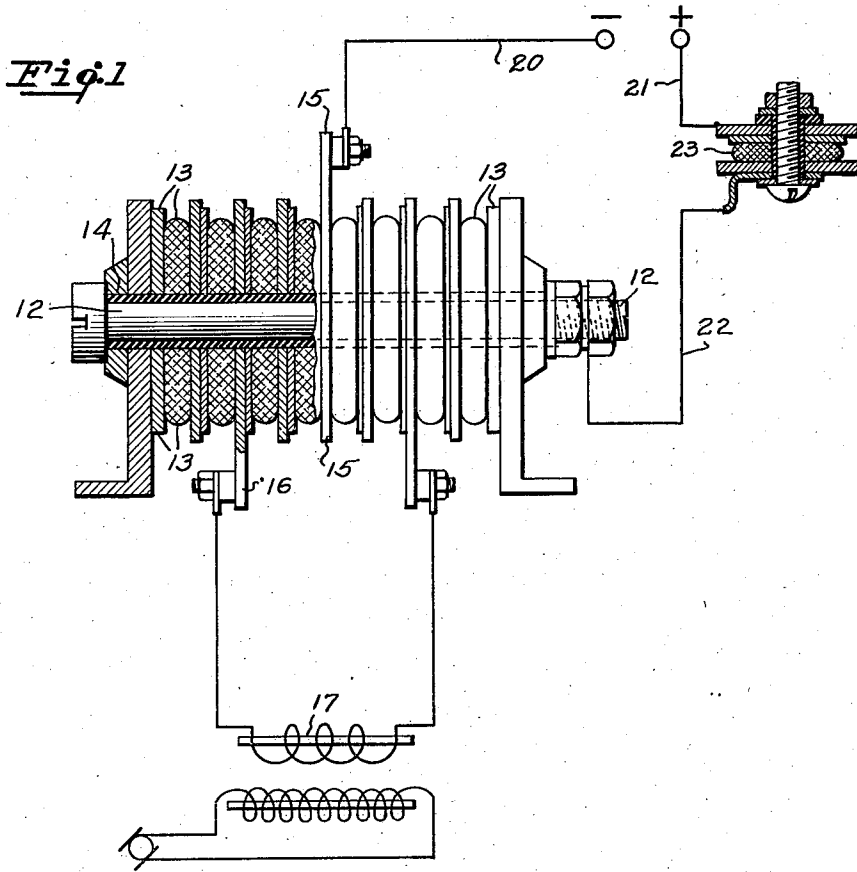
March 18, 1930.

S. RUBEN

1,751,359

ASYMMETRIC ELECTRIC COUPLE

Filed Aug. 20, 1925



INVENTOR

Samuel Ruben

BY

Mayer, Warfield & Watson
ATTORNEY

UNITED STATES PATENT OFFICE

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

ASYMMETRIC ELECTRIC COUPLE

Application filed August 20, 1925. Serial No. 51,524.

This invention relates to asymmetric electric couples and more particularly to electric couples adapted to be used in alternating current rectifying devices and the like, which are of the dry surface contact variety.

Rectifiers of this type are characterized by the use of a body of electropositive material, employed as one electrode element, disposed in electrical contact with a body of electronegative material employed as the other electrode element. Such rectifiers depend for their operation upon the resistance and current blocking characteristics of the film which forms at the junction of the electrode elements as the result of electrochemical action. Rectifiers of this character, known to the prior art, have been low in efficiency and limited in their application to small currents, becoming unstable after short periods of use.

The present invention accordingly has for its object, generally, to provide a device of the character specified which is efficient, economical and readily manufactured. Specifically, its object is to provide an arrangement of electrode elements in electric couples which is free from high internal resistance and low output voltage, and which are adapted for film formation and maintenance and do not require "aging" or other electrical or chemical operating development to insure unilateral conductivity.

This application is a continuation in part of my prior applications Serial No. 739,188, filed September 22nd, 1924, now Patent No. 1,649,741; Serial No. 750,539, filed November 18th, 1924, now Patent No. 1,649,742; Serial No. 754,956, filed December 10th, 1924; Serial No. 155, filed January 2nd, 1925, now Patent No. 1,649,743; Serial No. 13,143, filed March 5th, 1925, now Patent No. 1,649,744; Serial No. 14,657, filed March 11th, 1925; and Serial No. 38,780, filed June 22nd, 1925, now Patent No. 1,723,525. This application has been divided, to claim specifically the magnesium electrode element; the divisional application being Serial No. 415,411, filed December 20th, 1929.

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

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction 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 drawing, in which:

Figure 1 is a diagrammatic view of an electric current rectifier embodying the subject matter of the present invention; and

Fig. 2 shows schematically a dry surface contact electric couple constructed in accordance with the invention.

Referring now to the drawing, and particularly to Fig. 2, 10 denotes an electropositive electrode element in disk form which may be made of a relatively highly electropositive metal, for example magnesium. The electronegative electrode element is also of a disk-like or washer-shaped form, and is shown at 11 in direct contact with the electropositive element.

In the practice of the invention, the electronegative element here provided is a metallic compound with at least one of the elements of the sixth periodic group, which is commonly known as the sulphur group. While those elements thereof which are conductive, as, for example, tellurium or selenium, may be used in their normal state, still these elements or those elements thereof which are non-conductive, such as, for example, oxygen and sulphur, may be readily used when in combination with a metal forming a conductive compound, such as, for example, the oxides, sulphides, tellurides and selenides. These substances give asymmetrical electrical conductive effects when coupled with a relatively electropositive chemical element or compound, such as metallic magnesium, or its amalgam; and the greater the divergence in the electrochemical scale between the substances used for the electropositive and the electronegative electrode elements, the more effective the rectification.

It has also been discovered that current

rectification requires contact potential difference, and that if the initial or inherent contact potential is insufficient, as in the case of a couple composed of aluminum and cupric sulphide in contact, the desired contact potential difference may be attained by the interposition of a resistance between the elements, as, for example, by the oxidation of one of the elements.

A sulphided copper alloy lends itself readily to such use and may be considered as a somewhat flexible element capable of resisting the electrostatic forces by its movement in synchronism with the electric field. Such an alloy compound improves the physical characteristics of the couple, particularly by minimizing oxidation or decomposition when brought to a high temperature in air.

In the practice of the invention, the electronegative electrode element here provided is specially formed so as to have inherently the desired reacting properties in the process of forming and maintaining the inverse current blocking film at the junction with the electropositive electrode element without the use of an interposed resistance layer. By these properties, forming currents customarily employed in the so-called "aging" processes may be dispensed with.

An electronegative electrode of the character indicated above may be produced by employing a sulphided copper compound which is derived by the use of an alloy. A practicable method of providing such a substance will be found to be that of employing a copper alloy in which the alloy material has an inherently higher resistance than pure cupric sulphide, and thereafter heating the metal to approximately 800° C. in the presence of sulphur, and finally permitting the mass to cool. Thus, a copper compound is produced, the body of which has a higher specific resistance than that of pure cupric sulphide, and such a body will not require the use of a facing or intermediate oxide layer when utilized for electrical rectification purposes.

While other alloys may be employed, it is particularly desirable to form the electronegative electrode element from a copper compound, it being a preferable element, and readily forming the desired compounds, such as sulphide, selenide, telluride and oxides. The material added to vary its final resistance could be lead, tin, zinc, antimony, or any other that will itself form a sulphide or compound having a greater electrical resistance than the copper sulphide.

An assemblage of couples retained under suitable pressure is shown in Fig. 1, where 12 denotes a bolt which is passed through a plurality of aligned asymmetric couples 13 that are arranged in series in two groups inverted with respect to each other; the bolt 12 is insulated from these couples by means of a sleeve of insulation shown at 14. Interposed

between the inverted groups of asymmetric couples is a common electrode 15. This electrode is preferably disposed in contact with the electronegative electrode element of each group so that this electrode serves as a negative terminal, as indicated, for the circuit traversed by the rectified current.

Substantially midway of the series of asymmetric couples in each group is interposed an electrode 16; the electrodes so interposed are adapted to be connected across the terminals of a suitable source of alternating current, for example, the alternating current transformer shown at 17.

The arrangement of asymmetric couples in the rectifying device is adapted for full-wave rectification, since the outer end of each group of asymmetric couples is adapted to serve as a positive terminal, but, for simplicity of illustration, the circuit comprising the conductors 20, 21 and 22 is shown as connected to but one positive terminal so as to be traversed by only one-half of the alternating current wave received by the rectifying device. In series with the conductors 21 and 22 which connect with the positive terminal of the rectifying device shown in service, is connected a cut-out device shown generally at 23. This cut-out device may be of any convenient type, but is preferably one having unilateral conductivity and may be an asymmetric couple of the same type as used in the rectifying device itself.

It will be found that an electrical rectifier constructed in accordance with the present invention provides practicable units of high capacity, and its capacity is not limited by leakage or incompletely formed areas. When assembled the units require no formation process and are immediately on assembly commercially operable, in addition to the fact that the rectifier may be utilized in connection with low power transformers, for the reason that it does not require the intense formation current, or the reformation of any area due to hydrolytic or other secondary reactions. Also, the units are especially adapted for instantaneous or intermittent use, especially the latter, so that a device embodying the subject matter of the present invention can be employed to supplant storage batteries for such uses as signal circuits. Due to the initial rectification condition, and no formation current being necessary, it is now practicable to utilize a rectifier of this type in numerous novel associations, and because of its inherent asymmetrical conductive condition the discharge of a battery upon the interruption of the charging current is cut to a negligible minimum. Furthermore, where cupric compound disks are employed it will be found that these elements will resist breakage stresses, and even though relatively thin, they may readily be ground to have a hard, smooth surface, so that uniformity of pro-

duction may be assured, and the rectifier will not polarize by electrochemical reaction.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which as a matter of language might be said to fall therebetween.

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 comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a metallic compound with an element of the sixth periodic group alloyed to have inherently reaction properties adapted for the formation and maintenance of an inverse current blocking film at the junction of said electrode elements; said couple having means for maintaining the elements thereof united under pressure.

2. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a metallic base containing copper compounded with an element of the sixth periodic group and alloyed to have inherently reaction properties adapted for the formation and maintenance of an inverse current blocking film at the junction of said electrode elements; said couple having means for maintaining the elements thereof united under pressure.

3. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a metallic base containing copper compounded with a chemical element from the group including oxygen, sulphur, selenium and tellurium and alloyed to have inherently reaction properties adapted for the formation and maintenance of an inverse current blocking film at the junction of said electrode elements; said couple having means for maintaining the elements thereof united under pressure.

4. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of an alloy of the metals copper and zinc compounded with a chemical element from the sixth periodic group beginning with the letter "S" whereby the electronegative electrode element has inherently reaction properties adapted for the formation and maintenance of an inverse current blocking film at the junction of said electrode elements; said couple having means for maintaining the elements thereof united under pressure.

5. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a metallic compound with an element of the sixth periodic group alloyed to have inherently reaction properties adapted for the formation and maintenance of an inverse current blocking film at the junction of said electrode elements.

6. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a metallic body compounded with an element of the oxygen series of the sixth periodic group, said electronegative element having resistance properties adapted to react electrochemically when passing current whereby an inverse current blocking film is formed and maintained at the junction of said electrode elements.

7. In dry surface contact rectifying devices and the like, an asymmetric couple comprising an electropositive electrode element of magnesium, and an electronegative electrode element formed of a copper alloy, said alloy being compounded with an element of the oxygen series of the sixth periodic group, said alloy having components taken in respective amounts sufficient to impart resistance properties adapted to react electrochemically when passing current whereby an inverse current blocking film is formed and maintained at the junction of said electrode elements.

In testimony whereof I affix my signature.
SAMUEL RUBEN.