Jan. 29, 1935. H. F. FRUTH 1,989,311

ELECTRIC CURRENT RECTIFIER

Filed Jan. 9, 1934

Fig. 1

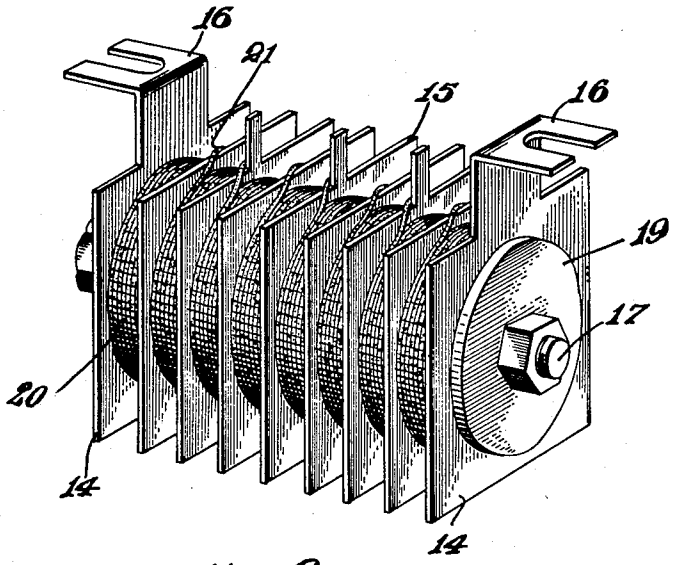


Fig. 2

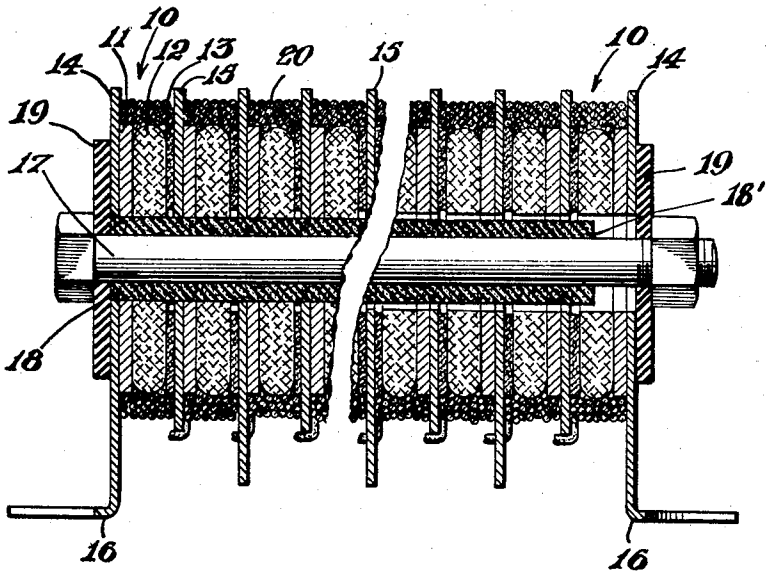


Fig. 3

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ELECTRIC CURRENT RECTIFIER

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16 Claims. (Cl. 175—366)

This invention relates to electric current rectifiers and the like which employ asymmetric or unilaterally conductive couples of the dry surface contact variety, the term "unilaterally conductive couple" as used hereinafter being intended to designate a device including an electrode element of a relatively electropositive material and another electrode element having a surface of a relative electronegative material adapted to cooperate with the former for the electrochemical formation and maintenance at their junction of an inverse current-blocking film which has the property of conducting current in one direction and blocking current in the reverse direction. More particularly, the invention relates to rectifiers of the type described in the copending application of Samuel Ruben, Serial No. 665,869 filed April 13, 1933 and assigned to the same assignee.

General objects of the invention are the provision of such couples having improved characteristics, which are efficient, economical and readily manufactured, and have long service lives; the provision in such couples of sealing means to prevent deterioration of the couples due to moisture, oxidization, and destruction due to salt water spray, etc., while additionally providing means for supplying to the couple during the operation elemental sulphur, selenium or tellurium in vapor form; and structural embodiments of the device which are readily constructed and allow efficient use and operation thereof.

A more specific object of the invention is the provision in such a device for the usual centrally disposed assembly bolt of a bushing or collar of fibrous material such as fibre or cardboard impregnated with a material adapted to supply to the couple during operation thereof a replenishing amount in vapor form of at least one of the elements sulphur, selenium and tellurium.

Another object of the invention is the provision in such a device of a layer of fabric material such as fibrous thread impregnated with a sealing compound such as a plasticized lacquer covering the exposed surfaces of the couple.

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 invention 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:

Fig. 1 is a perspective view of the device of the present invention;

Fig. 2 is an elevational sectional view with parts broken away of one form of the device depicted in Fig. 1; and

Fig. 3 is an elevational sectional view with parts broken away of another form of the device depicted in Fig. 1.

Many commercial dry rectifiers utilize couples wherein the electropositive electrode element is formed of magnesium and the other electrode element has a surface of electronegative material including at least one of the elements sulphur, selenium and tellurium in contact with the electropositive electrode element. By way of example, in using an electrode of magnesium in surface contact with cupric sulphide a rectifying layer is formed therebetween which is believed to be magnesium sulphide. While such couples are initially stable and capable of satisfactory operation under normal operating conditions for a time, it has been found that eventually the internal resistance increased, cupric sulphide was reduced to cuprous sulphide and/or to copper, an insulating oxide of magnesium was formed, internal heating was increased, copper oxide was formed and leaky and short circuited junctions were frequently developed. It was also found that in transoceanic transportation of the devices salt water spray caused corrosion and destruction of the units. Some of these difficulties appeared to develop from moisture in the atmosphere and others from the oxidizing effect thereof. Sealing, while tending to solve some of these problems, increased the heating with a consequent tendency to oxidize the sulphide layer. The use of sealing varnishes or lacquers was attended by further difficulties in that alternate heating and cooling soon caused the sealing compound to become brittle, eventually to crack and to leak.

These and other difficulties of the prior art are efficiently overcome by the present invention. By using a fabric material such as fibrous thread, for example, cotton thread, impregnated with a sealing compound, for example a plasticized varnish or lacquer, the difficulties due to salt water spray and gases, atmospheric oxidation and moisture deterioration, and cracking and leakage of sealing coatings are avoided. Avoidance of at least some of these features is augmented by a collar or bushing about the transfixing assembly bolt. The collar or bushing is formed of

a fibrous material, preferably from fibre or cardboard, and is impregnated with a material including at least one of the elements sulphur, selenium and tellurium. Heat developed by operation of the rectifier causes the formation of a vapor of the element or elements impregnated into the bushing which aids in the exclusion of an oxidizing atmosphere, prevents reduction of the rectifying layer constituting a compound thereof and acts as a replenishing supply of the element or elements aiding in the maintenance of the rectifying layer thereby insuring continued efficient operation of the rectifier.

Referring to the drawing like numerals refer to like parts throughout. A structural embodiment of rectifiers of the type indicated which incorporates the features of the present invention is depicted. The rectifier makes use of a plurality of elemental unilaterally conductive couples 10—10, each of which includes an electropositive electrode element 11 of any suitable electropositive material such as, for example, aluminum or magnesium which has been slightly oxidized; an electronegative electrode element 12 of any suitable electronegative material, preferably one which has a surface of an electronegative material including at least one of the elements sulphur, selenium and tellurium, for example cupric sulphide; and a layer 13 of nonpolarizing material, such as a disc of carbonized nickel. Each of the couples 10 are provided with a pair of terminal plates 14 and 15 and as shown in the drawing when a plurality of couples are mounted in series, the terminal plate 15 of the preceding couple is placed in contact with the electropositive electrode element 11 of the succeeding couple, thereby making unnecessary the use of an additional terminal plate 14 for the succeeding couple. The end terminal plates, as shown, are provided with projecting feet 16, 16 for ready mounting of the unit.

The electrodes 11 and 12 and layers 13 of nonpolarizing material are apertured as shown and mounted upon an assembly bolt 17 surrounded by a collar or bushing 18 of fibrous material, preferably fibre or cardboard, impregnated with a material including at least one of the elements sulphur, selenium and tellurium.

As previously explained, this collar or bushing provides a source for at least one of the elements sulphur, selenium and tellurium in vapor form during the operation of the rectifier unit. This bushing may provide suitable insulation to prevent short-circuiting of the couples by the bolt 17 as indicated in Fig. 2, and cooperates with the end terminal plates and end plates 19, 19 to form an internal seal for the couple which is augmented by the formation of the vapor during the operation of the device. Such a bushing will perform its bushing functions satisfactorily at operating temperatures while being capable of carrying sufficient material including at least one of the elements sulphur, selenium and tellurium to provide a source for sufficient vapor throughout desirably long periods of efficient operation of the device.

However, as depicted in Fig. 3, spacing may be used to prevent short-circuiting by the bolt 17, the elements being held in their relative positions by the clamping action of the bolt and sealing of the interior of the rectifier unit being obtained by the end plates 19, 19, which is augmented by the vapor formed during operation, the impregnated collar 18' serving as a source for this vapor.

Various methods may be followed in preparing the collars or bushings of the present invention. For example, a porous fibre tube may be immersed in molten sulphur at a temperature of about 130° C. until all bubbling ceases. This may require an immersion for about 30 minutes. In addition, the tube may be vacuum impregnated with the desired material or may be impregnated with a solution of sulphur dissolved in carbon bisulphide. Other similar and suitable methods will readily occur to those skilled in the art.

External sealing of the couples is obtained by the use of a layer 20 of fabric material impregnated with a sealing compound. The layer 20 is preferably in the form of layers of fibrous thread 21, such as cotton thread, impregnated preferably with a plasticized varnish or lacquer as shown. The thread may be saturated with the sealing compound and then wound about the couples to constitute layers thereof, but is preferably wound about the couples in unsaturated condition after which the rectifier unit is dipped in or sprayed with the plasticized varnish or lacquer. It will be obvious that this type of external sealing may be used on dry rectifier units of any type falling within the definition indicated above, as well as being suitable for use on rectifying units utilizing the particular types of couples described. Rectifiers externally sealed in the manner indicated above were submitted to an 80 per cent humidity test and after six weeks were found to be in perfect condition. They were also submitted to a salt spray test for a ten day period and were found to be in perfect condition at the end of that time. Similar units provided with old style coatings of lacquers submitted to the same tests were found to have failed after a two day period and in certain instances were found to fail in a shorter time.

As is well known in the art and more fully set forth in the application of Samuel Ruben identified above, many elements and combinations thereof can be used in the formation of rectifier electrodes. Those using electrodes having a surface of a relatively electronegative material including one or more of the elements sulphur, selenium and tellurium are improved in operation by the use of bushings of the present invention. It is preferable, but not essential, that those of the elements sulphur, selenium and tellurium present in the electronegative material should be present in the electronegative material with which the bushings are impregnated. However, for example, when the electronegative electrode element has a surface of cupric sulphide, a bushing may be used which is impregnated with a material including selenium whereby during operation of the device vaporized selenium is supplied to the device for the formation of a selenide, which, with the sulphide, will constitute a rectifying layer.

In accordance with the present invention any known type of dry rectifier falling within the general class indicated by the definition of "unilaterally conductive couple" can be improved as indicated by the use of an internally disposed tube of fibrous material impregnated with a material adapted to supply to the couple during operation a vapor of the same element which is a component of the compound constituting the rectifying layer.

It will thus be seen that the present invention efficiently attains the objects set forth above and 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 electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material each of which is adapted to supply at least one element for the electrochemical formation and maintenance of a compound constituting an inverse current-blocking film at their junction; of a centrally disposed tube of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of said elements, and a layer of fabric material impregnated with a sealing compound covering the exposed surfaces of said couple.

2. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium; of a centrally disposed tube of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a sealing compound covering the exposed surfaces of said couple.

3. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium, and means to secure said electrodes in surface contact; of a collar of fibrous material about said securing means impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a sealing compound covering the exposed surfaces of said couple.

4. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a centrally apertured electrode of relatively electropositive material, another centrally apertured electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium, terminal plates disposed on the ends of said couple, and centrally disposed means to secure said electrodes in surface contact between said terminal plates; of a bushing of fibrous material for said securing means impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a sealing compound covering the exposed surfaces of said couple between said terminal plates; said bushing, terminal plates and said layer cooperating to seal said couple.

5. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a centrally apertured electrode of relatively electropositive material, another centrally apertured electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium, terminal plates disposed on the ends of said couple, and a centrally disposed bolt to secure said electrodes in surface contact between said terminal plates; of a bushing of fibrous material surrounding said bolt impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a sealing compound covering the exposed surfaces of said couple between said terminal plates; said bushing, terminal plates and said layer cooperating to seal said couple.

6. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium; of a centrally disposed tube of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a plasticized lacquer covering the exposed surfaces of said couple, the vapor supplied by said centrally disposed tube during operation of said couple and said layer cooperating to seal said couple.

7. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a centrally apertured electrode of relatively electropositive material, another centrally apertured electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium, terminal plates disposed on the ends of said couple, and centrally disposed means to secure said electrodes in surface contact between said terminal plates; of a bushing of fibrous material for said securing means impregnated with with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fabric material impregnated with a plasticized lacquer covering the exposed surfaces of said couple between said terminal plates; said bushing terminal plates and said layer cooperating to seal said couple.

8. In a unilaterally conductive couple comprising a centrally apertured electrode of relative electropositive material, a centrally apertured electrode having a surface of relatively electronegative material including at least one of the elements sulphur, selenium and tellurium in surface contact with said first-mentioned electrode, terminal plates disposed on the ends of said couple, and a clamping bolt transfixing said terminal plates and said electrodes; the combination comprising a collar of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and

tellurium, and a layer of fibrous thread impregnated with a plasticized lacquer covering the exposed surfaces of said couple between said terminal plates, the vapor supplied by said collar during operation of said couple cooperating with said layer to seal said couple.

9. In a unilaterally conductive couple comprising a centrally apertured electrode of relatively electropositive material, a centrally apertured electrode having a surface of relatively electronegative material including at least one of the elements sulphur, selenium and tellurium in surface contact with said first-mentioned electrode, terminal plates disposed on the ends of said couple, and a clamping bolt transfixing said terminal plates and said electrodes; the combination comprising a bushing of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fibrous thread impregnated with a plasticized lacquer covering the exposed surfaces of said couple between said terminal plates, said bushing being disposed between said terminal plates and surrounding said bolt and cooperating with said layer and said terminal plates to seal said couple.

10. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising an electropositive electrode, an electronegative material, and an inverse current-blocking film at their junction consisting of an electrochemically formed compound; of an internally disposed tube of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements making up said electrochemically formed compound.

11. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple utilizing an electronegative material including at least one element chosen from the group containing sulphur, selenium and tellurium; of a centrally disposed collar of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium.

12. In a unilaterally conductive couple a bushing for a transfixing assembly bolt formed of fibrous material and impregnated with a material adapted to supply to said couple a vapor of at least one of the elements sulphur, selenium and tellurium.

13. In a unilaterally conductive couple utilizing a centrally disposed assembly bolt, a bushing surrounding said bolt formed of fibrous material and impregnated with a material adapted to supply to the said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium.

14. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material, each of which is adapted to supply at least one element for the electromechanical formation and maintenance of a compound constituting an inverse current-blocking film at their junction; of a core of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of said elements, and a layer of fibrous material impregnated with a sealing compound covering the exposed surfaces of said couple.

15. In electric current rectifiers and the like, of the dry surface contact variety, the combination with a unilaterally conductive couple comprising a relatively electropositive electrode, another electrode having a surface of a relatively electronegative material including at least one element chosen from the group sulphur, selenium and tellurium; of a core of fibrous material impregnated with a material adapted to supply to said couple during operation thereof a vapor of at least one of the elements sulphur, selenium and tellurium, and a layer of fibrous material impregnated with a sealing compound covering the exposed surfaces of said couple.

16. In a unilaterally conductive couple a core of fibrous material impregnated with a material adapted to supply to said couple a vapor of at least one of the elements sulphur, selenium and tellurium.

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