May 9, 1933. R. D. MERSHON 1,908,039

ELECTROLYTIC RECTIFIER

Filed Nov. 18, 1930

Fig. 1.

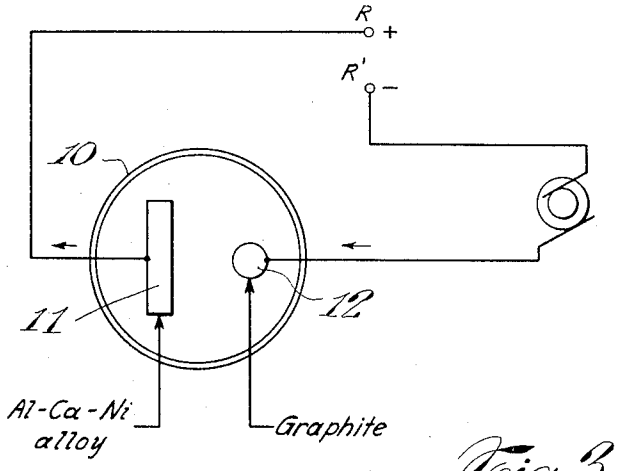


Fig. 2.

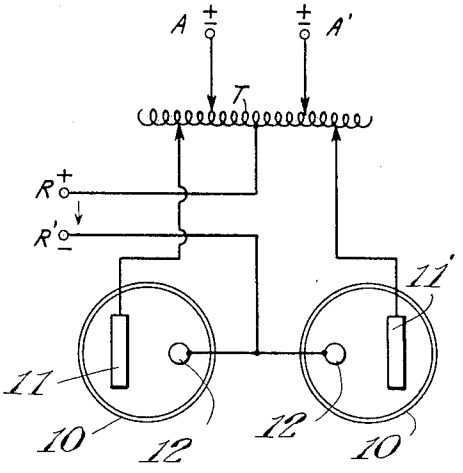


Fig. 3.

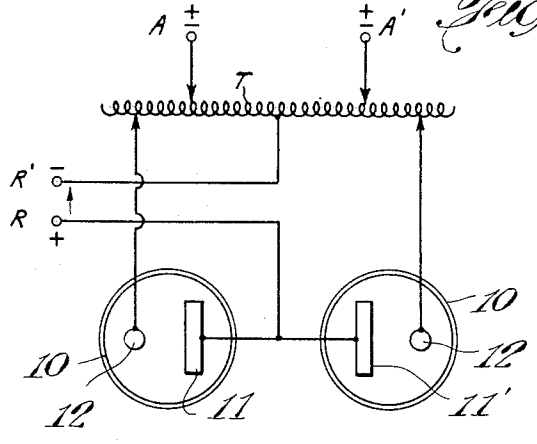


Fig. 4.

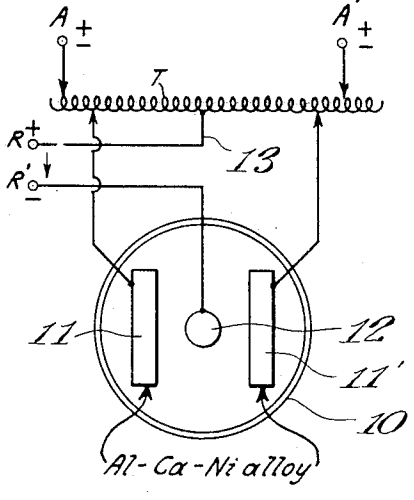
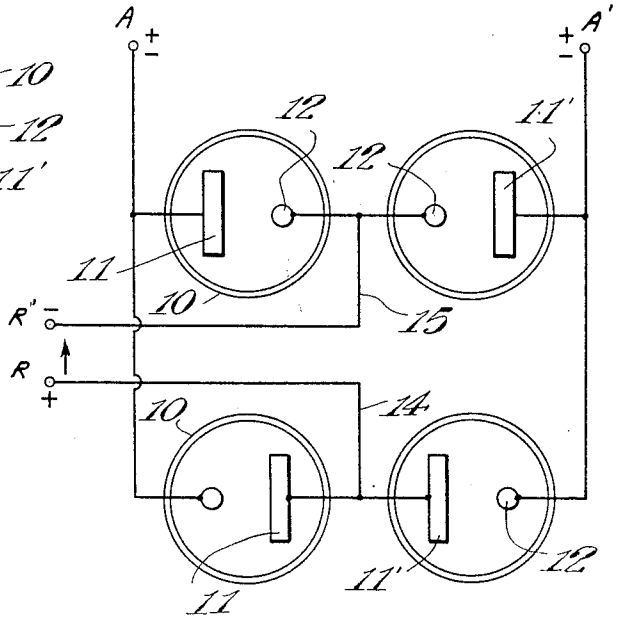


Fig. 5.



INVENTOR

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Patented May 9, 1933

1,908,039

UNITED STATES PATENT OFFICE

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ELECTROLYTIC RECTIFIER

Application filed November 18, 1930. Serial No. 496,441.

This invention relates to electrolytic rectifiers, for converting alternating voltage and current into direct. As is well known, such devices depend for their operation upon the film which may be formed upon the surface of certain metals and which possesses the peculiar property of offering low resistance to the flow of current from the electrolyte to the metal but relatively high resistance to current tending to flow from the metal to the electrolyte. If, when, an electrode having such a film and an electrode of non-filming metal or other conducting material are immersed in a suitable electrolyte and the two are connected to a source of alternating current only the current impulses which are positive with respect to the filmed electrode will be suppressed and those which are positive with respect to the non-filming electrode will pass through the device. Hence the current from the filmed electrode will be unidirectional, though more or less pulsating in character. If two filmed electrodes are used both current impulses of each cycle may be rectified.

By reason of their simplicity and relatively low cost such devices offer attractive possibilities, but these possibilities have been found difficult to realize in practice. In the first place, when the filmed electrodes are made of pure metal (or metal containing nothing else but the impurities found in commercial grades, which impurities are usually silicon, titanium and iron, sometimes copper also), the efficiency of the rectifier is low, especially when the electrolyte is hot, as it is apt to be by reason of the losses due to the resistance encountered by the current. Also, the filmed metal is subject to rapid corrosion due to the repeated break-down and re-formation of the film incident to the rectifying action. These drawbacks are to a considerable extent overcome by making the filmed electrodes of an alloy of aluminum, magnesium and copper, as described and claimed in my copending application Serial No. 317,610, filed November 6, 1928, but in the course of continued investigation I have found that aluminum alloyed with calcium, and preferably containing nickel also, is still better, as evidenced by longer life and by high efficiency even at boiling temperature. Advantageous results can be obtained with less, but I prefer to use at least about three per cent of calcium and two per cent of nickel. A like amount of copper may be used, but I consider nickel better. Of the latter element I may use as much as six per cent, and in some cases more, but I have not observed that the results are any better than with about 4 per cent. As for the calcium content I have not found that more than ten per cent offers any material advantage, but the invention is not limited to that amount since the alloy may contain calcium up to the maximum that can be alloyed with aluminum or with aluminum and nickel. Eight per cent of calcium is a good average amount, being satisfactory for impressed voltages exceeding 200 volts (R. M. S.) as well as for lower. Using an alloy composed of aluminum 88 per cent, calcium 8 per cent, and nickel 4 per cent, approximately, with a condenser in parallel with the D. C. terminals of the rectifier, I have obtained an efficiency of 69 per cent over long periods of time, even with the electrolyte boiling. At first the efficiency may be as high as 88 per cent or higher. Instead of nickel I may use other metals such as copper, cobalt, or silicon, but the electrical results are less advantageous. In general I may use any one or more of the metals nickel, copper, cobalt and silicon.

My experience indicates that an acid electrolyte, say one containing borax or sodium phosphate and boric or phosphoric acid gives substantially better results in the long run than a neutral or alkaline electrolyte, say one containing only borax or sodium phosphate or sodium hydroxid. I prefer, however, a solution containing one-half pound of anhydrous sodium tetraborate and one and a half pounds of boric acid per gallon of water.

For the non-filming electrode carbon may be used, or any non-filming metal, preferably one which is not readily deposited on the filming electrodes, as for example high-silicon iron, but I prefer graphite, as it re-

sists well the chemical or electrochemical attack incident to the operation of the rectifier. The metal tank or vessel containing the electrolyte may be used as the non-filming electrode, as is common in the art.

In the accompanying drawing,

Figs. 1. 2, 3, 4 and 5 illustrate diagrammatically various forms of electrolytic rectifiers in which my invention may be embodied.

Throughout the drawing, 10 is a tank or vessel for the electrolyte, 11, 11′ are filmed electrodes of aluminum-calcium-nickel alloy, 12 is a non-filming electrode of graphite, T is an auto-transformer or balance coil, R, R′ are the terminals for the rectified output, one connected to the neutral point of the balance coil and the other to the anode or anodes 12. A, A′ are the input terminals for connection with a source of alternating voltage and current.

In Fig. 1 the rectifier has one filming electrode and is therefore of the "half-wave" type, that is, positive impulses impressed upon the filmed electrode 11 are suppressed and only those which are impressed on the non-filming electrode 12 are passed. In Figs. 2 and 3 two cells such as are shown in Fig. 1 are used for full-wave rectification, in the one case with the filmed electrodes connected to the transformer or balance coil and in the other with the non-filming electrodes connected thereto. In Fig. 4 both filmed electrodes are in the same vessel and only one non-filming electrode is needed. When both filmed electrodes are in the same tank a balance coil or transformer is necesesary, as in Fig. 4, for example, and also in the arrangements shown in Figs. 2 and 3, in which only two half-wave cells are used. With four or more such cells they may be connected as in Fig. 5, in which case no balance coil or transformer is needed, though a transformer may be employed as a convenient means for stepping the impressed alternating voltage up or down.

The rectifying operation will be readily understood by tracing the course of the current in any of the figures. For example, assume in Fig. 4 an impulse coming in from terminal A′. Unable to pass through the film on electrode 11′ the current flows through conductor 13 to terminal R, thence through the translating device (not shown) connected to terminals R, R′, and from the latter terminal to the non-filming electrode 12, the electrolyte, filmed electrode 11, and thence to the transformer T and out through terminal A. When the alternating voltage reverses the flow is from terminal A through conductor 13, terminals R, R′, unfilmed electrode 12 and filmed electrode 11 to terminal A′. In Fig. 5 an impulse coming in at terminal A′ flows through unfilmed electrode 12 in the lower tank at the right, filmed electrode 11′ in the same tank, conductor 14, terminals R, R′, conductor 15, unfilmed electrode 12 in the upper tank at the left, filmed electrode 11 in the same tank, and thence to terminal A. When the alternating voltage reverses, the current flows first through the lower cell at the left and out through the upper cell at the right.

It is to be understood that the invention is not limited to the specific details herein described but can be carried out in other ways without departure from its spirit.

I claim—

1. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy.

2. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy containing nickel.

3. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy containing copper.

4. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy having a calcium content not less than about 3 per cent.

5. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy having a calcium content from 3 per cent to 10 per cent, approximately.

6. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy containing not less than about 2 per cent of nickel.

7. An electrolytic rectifier having an electrode made of an aluminum-calcium alloy containing from about 2 per cent to 6 per cent of nickel.

8. An electrolytic rectifier having an electrode made of aluminum-calcium alloy having a calcium content of from 3 to 10 per cent, approximately, and containing from about 2 to 6 per cent of nickel.

9. An electrolytic rectifier having an electrode made of aluminum-calcium alloy having a calcium content of about 8 per cent and containing about 4 per cent of nickel.

10. An electrolytic rectifier having an electrode made of aluminum-calcium alloy containing at least one other metal of the class consisting of nickel, cobalt, copper and silicon.

11. An electrolytic rectifier comprising a filmed electrode composed of aluminum-calcium alloy, a non-filming electrode, and an electrolyte in which said electrodes are immersed, containing an acid of the class of boric and phosphoric acids.

12. An electrolytic rectifier comprising a filmed electrode composed of aluminum-calcium alloy, a non-filming electrode, and an electrolyte in which said electrodes are immersed, containing borax and boric acid in solution.

13. An electrode for an electrolytic recti-

fier composed of aluminum-calcium alloy.

14. An electrode for an electrolytic rectifier, composed of aluminum-calcium alloy containing nickel.

15. An electrode for an electrolytic rectifier, made of an alloy composed of aluminum 88 per cent, calcium 8 per cent, and nickel 4 per cent, approximately.

In testimony whereof I hereto affix my signature.

RALPH D. MERSHON.