May 9, 1933. V. BUSH 1,908,316

RECTIFYING APPARATUS

Filed Oct. 1, 1926

Fig. 1

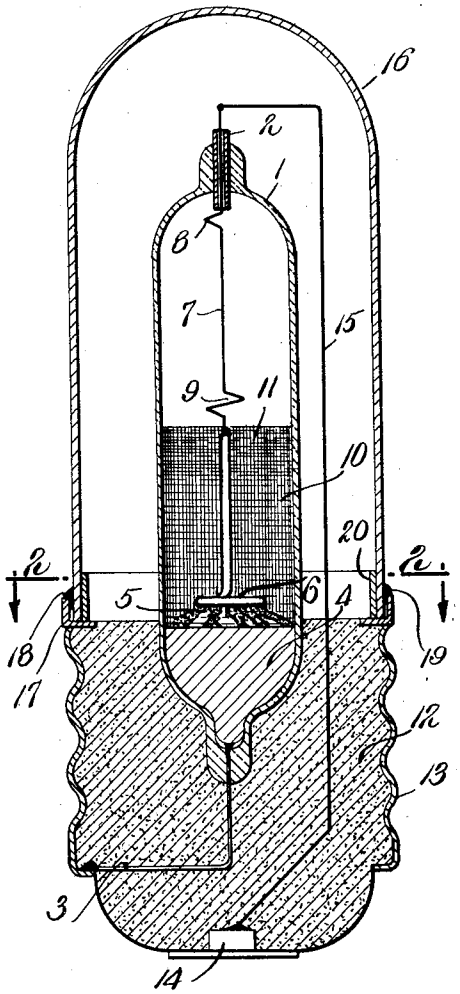


Fig. 2

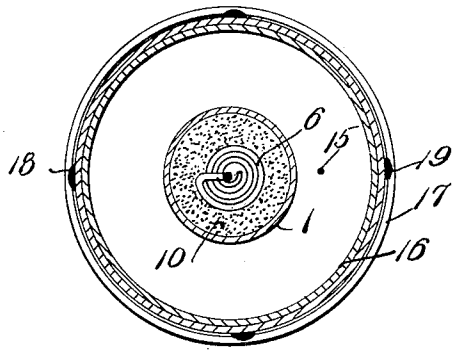


Fig. 3

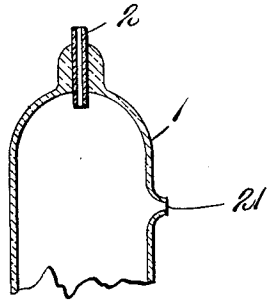


Fig. 4

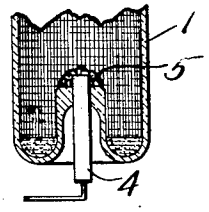
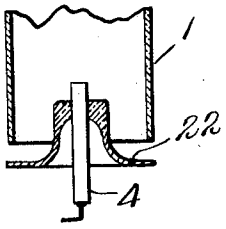


Fig. 5



Inventor
Vannevar Bush
by Roberts, Cushman & Woodbury
Attys.

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UNITED STATES PATENT OFFICE

VANNEVAR BUSH, OF WEST MEDFORD, MASSACHUSETTS, ASSIGNOR TO RAYTHEON INC., OF CAMBRIDGE, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

RECTIFYING APPARATUS

Application filed October 1, 1926. Serial No. 138,899.

The present invention relates to electrical apparatus and in particular to alternating current rectifiers in which two metals of different character are employed as electrodes, the metals alternately fulfilling the function of cathode and anode respectively.

Application Serial No. 749,214, filed November 11, 1924 by Henri G. André discloses a rectifier, one electrode of which comprises a metallic colloid while the other is formed of a material that when subject to an oxidizing agent, yields a compound permeable to current in one direction only. In the application identified, there is stated the presence and manner in which derived, of an element in colloidal form making physical contact with one of the electrodes and in particular with the cathode. Apparatus made according to the foregoing specification has the property of rectifying alternating current of comparatively large amplitude. The subject matter described hereinafter consists of improvements both in the mode of manufacture and in structure of the foregoing device, the object of the invention being to produce greater reliability in the operation of a rectifier of the colloid type, and also to decrease the cost of manufacture by reducing the number of parts involved. Other features will be apparent as the specification is perused.

The accompanying drawing in which similar reference characters designate corresponding elements throughout the several views illustrates an exemplary embodiment of the device forming the subject of the present invention.

Fig. 1 is a vertical section of the improved rectifier;

Fig. 2 is a section taken on line 2—2 of Fig. 1;

Fig. 3 is a section of the upper part of the receptacle showing an alternative method of introducing an oxidizing agent;

Fig. 4 is a section of the lower part of the receptacle illustrating an alternative method of sealing the cathode; and

Fig. 5 represents the relation of a tube and stem before being joined together to form the receptacle shown in Fig. 4.

Referring to the illustration, the invention in its preferred form consists of envelope 1, made of quartz or glass as pyrex, the upper and lower ends of which are sealed about fine glass tube 2, having a direction parallel to the principal axis of the envelope, and lead wire 3 respectively. The latter is preferably of a ferrous-nickel alloy having substantially the same coefficient of expansion as the envelope. When the envelope is formed of pyrex glass, the alloy contains approximately 33% nickel, this alloy being known as invar.

The rectifier proper consists of cathode 4 made preferably of cylindrical form to fit the inner diameter of envelope 1 and of a material characterized by strong electrolytic oxidation, for example, aluminum, nickel or an alloy as nickel-silicon containing 25 to 32% silicon and nickel-iron. The cathode is in intimate contact with colloidal anode 5 formed in place electrolytically by action of the alternating potential to be rectified in the manner set forth and claimed in the André application Serial No. 138,924 filed October 1, 1926. However, if desired, the colloid may be obtained by well-known chemical processes and deposited manually on the cathode as stated in application Serial No. 749,214 supra.

Reference character 6 designates a conductor of material, as silver, the oxidation compounds of which are good conductors of electrical energy and able to withstand attack by acid, surfacial oxidation excepted. As will be noted in Fig. 2 the conductor terminates in a spiral, horizontally placed, exposing a large surface to facilitate electrolytic action and ensuring abundant supply of material to form colloid. This electrode is suspended in the glass envelope by lead wire 7 passing through fine tube 2, the wire being preferably of the same metal as the electrode to which it is attached.

Referring to Fig. 1, two kinks 8 and 9 will be noted, that uppermost serving to retain fine tube 2 in a vertical position during the sealing process as will be explained hereinafter. Kink 9 has for its purpose preventing the movement of glass wool 10. For electrolyte 11, indicated by horizontal lines, which completely submerges electrode 6, I prefer

sulphuric acid having concentration of approximately 66° Baumé combined with an anhydrid as set forth in the André application referred to. I have found that particularly good results are obtainable when 40 grammes of anhydrid are added per 100 cubic centimeters of acid.

At 10, by vertical lines, I have indicated a quantity of glass wool so-called, to effectively hold by absorption, acid superfluous or in loose form, enabling the rectifying unit to be handled without spill. It will be further noted that the wool fibers are arranged to facilitate gas flow during the initial colloid forming period, i. e. in a direction parallel to the principal axis of the tube. Cathode 4 is welded to lead 3 and the lower end of envelope 1 is fused about the cathode to make a snug fit. By making the latter of an alloy having substantially the same coefficient of expansion as the material comprising the envelope, it may be sealed but ordinarily it is sufficient to make its coefficient only close enough to that of the envelope material to prevent a substantial quantity of liquid seeping between the cathode and envelope to lead 3 where electrolysis would be deleterious.

The entire rectifying unit is secured by plastic material 12 in a base 13 of the Edison screw type, the base being connected to the cathode by lead 3. The base terminates in metallic member 14 which is connected to the anode by lead 15.

For the purpose of protecting the unit from external injury and also for convenience in handling, I provide a container or casing 16, preferably of nickel plated iron. This container is closed to the atmosphere and rests in flanged annular ring 17 to which it is soldered at a few points as 18, 19 about the periphery. This form of joint effectively secures the container to the base but allows gas emitted by the electrolyte to escape between the globules of solder. The casing 16 also affords protection from the escape of acid, either in vapor or liquid form, as for example, in case the glass envelope should be broken, inasmuch as it is substantially liquid tight; however, in case of breakage of envelope, the acid is neutralized by the time it has penetrated through the container. The flange 17 also helps to prevent escape of liquid under the lower end of the container. In order further to ensure complete neutralization of any acid passing to the upper surface of base 12, a ring 20 of zinc or other suitable material, may be provided.

In the manufacture of my improved rectifier, procedure is as follows: lead 3 is first joined by spot welding to cylindrical cathode 4, the lead being covered with borax and the unit inserted into glass tubing. One end of the tubing is sealed about the lead wire, the coating of borax aiding in securing a good joint. Conductor 6 to which has been attached by welding, kinked silver wire 7, is then inserted into the tubing and firmly held in proper spacing from the cathode by glass wool 10, the latter being placed about said conductor. Fine tube 2 of glass is then slipped over the straight portion of the silver lead and held in position by kink 8 while envelope 1 is sealed. It will be noted that a tight joint is first formed between the glass tube 2 and lead 7, but soon thereafter the silver tends to part leaving a vent for gas. The rectifier unit, after being heated slightly by baking in an oven or by enclosing in a solenoid of hot resistance wire, is immersed, the end containing tube 2 foremost, in an electrolyte forming liquid. As the envelope cools, a measured quantity of liquid is drawn through fine tube 2 and is immediately absorbed by glass wool 10. The unit is now ready for mounting in the base which is done in the manner employed in the lamp art, connections being made to the leads, the container including zinc strip being secured in the flanged ring by soldering.

Fig. 3 shows an alternative method of introducing the electrolyte which consists in blowing a hole 21 in the side of envelope 1, injecting the liquid by a syringe and tipping off the opening. However, I have found the immersion process to be superior.

Figs. 4 and 5 illustrate an embodiment which offers simplicity in making the lower seal and affixing the cathode. Numeral 22 (Fig. 5) designates a circular glass plate member of convex shape sealed to a tube of glass to form the lower portion of envelope 1. In these figures cathode 4 consists of a nickel silicon rod sealed in member 22, which constitutes the lower portion of envelope 1.

While throughout the foregoing description I have specified the cathode as of a nickel or aluminum alloy by way of example, other metals and alloys are adapted for this function. The requirements of such member are simply that its oxidation product shall be unilaterally conductive and in the case of an electrode in rod form as shown in Fig. 4, it shall also have a coefficient of expansion commensurate with the material forming plate member 22. When the latter is of glass, I find that nickel combined with 28% silicon ensures a substantial gas and liquid seal.

I claim:

1. In a rectifier, the combination of a cathode having a unilaterally conducting film and a colloid producing non-film-forming electrode in spiral form located adjacent said cathode.

2. A rectifier having a film-forming cathode and an additional non-film-forming electrode with a mass of finely divided conducting material substantially bridging the space therebetween, the material comprising the disintegration product of said additional electrode, characterized in that the additional

electrode is transversely enlarged at the end presented to said cathode.

3. A rectifier having a film-forming cathode and an additional non-film-forming electrode with a mass of finely divided conducting material substantially bridging the space therebetween, the material comprising the disintegration product of said additional electrode characterized in that the additional electrode comprises a spiral whose axis is approximately perpendicular to the opposed face of the cathode.

4. A rectifier having a film-forming cathode and an additional non-film-forming electrode with a mass of conducting particles substantially bridging the space therebetween and a fibrous material in the region of said space for holding said particles in position, the fibres extending predominately in a direction longitudinal of the electrodes.

5. In a rectifier, the combination of an electrode, the oxidation product of which is a unilateral conductor, a colloid forming non-film-forming electrode separated therefrom by a film forming electrolyte absorbed in a fibrous material, the fibres of which are arranged in a direction to facilitate gas flow.

6. In combination, a unilateral conductor operating electrolytically and subject to gas formation, an enclosure therefor comprising a container fitted into a base member and a common means for securing the container to said base member and for allowing escape of the gas.

7. In the manufacture of a cell containing electrodes and a liquid, the method of introducing the liquid which comprises closing the cell except for a small inlet, submerging the mouth of said inlet in liquid and cooling the cell to draw the liquid through the inlet.

8. An anode for use in an electrolytic apparatus, said electrode containing between 25 and 32 per cent. silicon.

9. In electrical apparatus, the combination of a glass envelope and an electrode sealed therein containing about 28% silicon whereby sealing is promoted.

10. An electrode for use in electrolytic apparatus composed of nickel alloy having a silicon content about 28%.

11. An electrical apparatus, including a frangible envelope, containing an acid, said envelope being supported in a non-frangible casing, and a material in said casing and exterior to said envelope for neutralizing acid which may escape from said container upon possible fracture thereof.

12. In an electrical apparatus, a body of glass having sealed therethrough a metal conductor, said metal conductor consisting of a nickel alloy having a silicon content of the order of about twenty-eight per cent.

13. In an electrical apparatus, the combination of a glass envelope and an electrode sealed therein, said electrode consisting of a nickel alloy having a silicon content of the order of about 28 per cent.

14. In an electrical apparatus, a glass envelope, an electrode in said envelope, a lead-in conductor sealed in the wall of said envelope and connected to said electrode, said envelope containing a material which may attack the lead-in conductor at its sealing point, said electrode having a coefficient of expansion substantially the same as that of the envelope, said electrode also snugly fitting inner walls of said envelope and forming a seal between said material and said lead-in conductor.

Signed by me at Cambridge, Massachusetts this 31st day of August 1926.

VANNEVAR BUSH.