March 28, 1933. H. J. SPANNER ET AL 1,903,144

RECTIFYING TUBE

Filed March 11, 1929

Fig. 1.

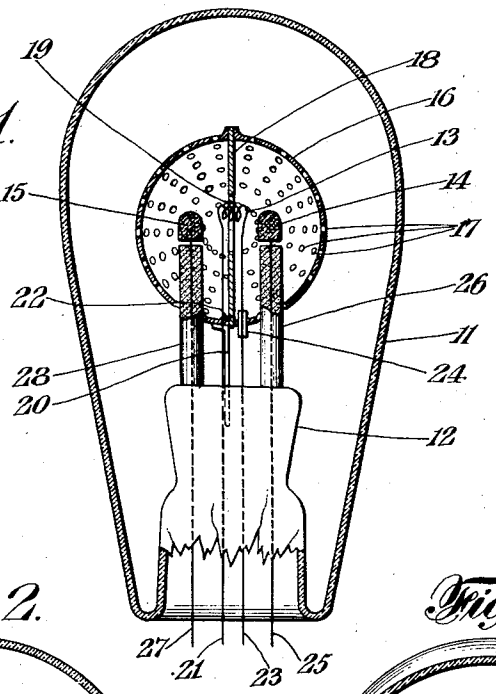


Fig. 2.

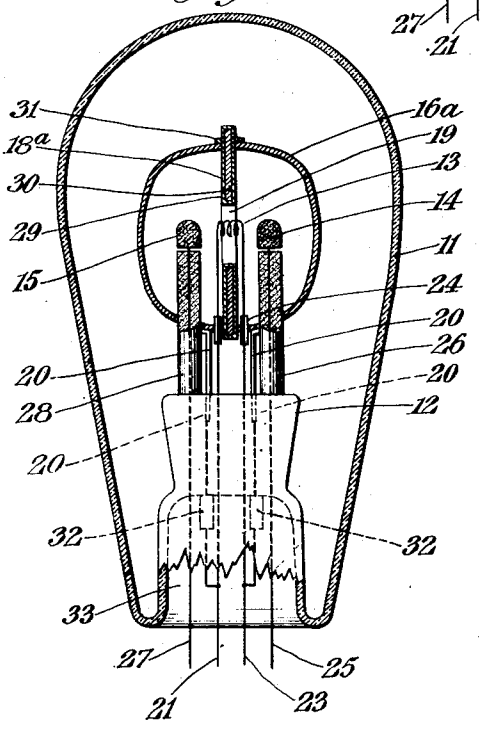
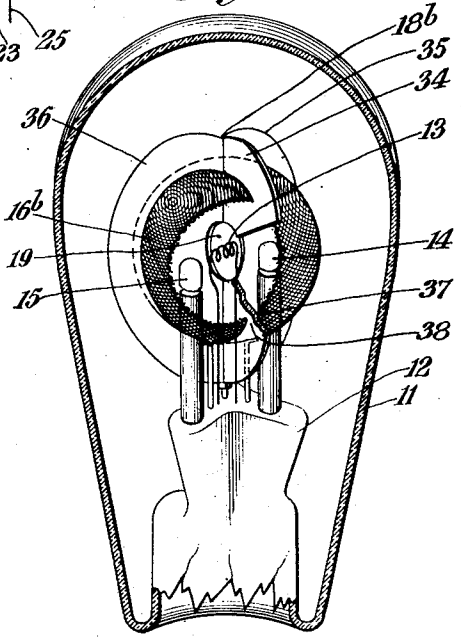


Fig. 3.



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Patented Mar. 28, 1933

1,903,144

UNITED STATES PATENT OFFICE

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RECTIFYING TUBE

Application filed March 11, 1929, Serial No. 346,119, and in Germany June 19, 1928.

This invention relates to rectifying devices and more particularly to such devices which have a hot and emitting cathode and which are gas filled and operate by means of an electric discharge through an ionized gas as distinguished from rectifying devices which operate by means of a pure electronic discharge.

Among the objects of the invention is the production of a rectifying tube capable of operating at higher voltages and with a greater current capacity than has been heretofore the practice.

Further objects are the attainment of a higher efficiency and longer life and also freedom from external disturbances.

In order to confine the discharge path within as small a region as possible a chamber or inclosing shell is provided which surrounds the electrodes. Because of the limited space within which the discharge then takes place it is desirable to provide screens or partitions between the anodes to prevent discharge therebetween.

In order to more clearly explain the invention, reference is made to the following description of different embodiments thereof taken in connection with the accompanying drawing, in which

Fig. 1 is a vertical view, chiefly in section, of a rectifying tube in which an inclosing shell and dividing partition are electrically connected to the cathode;

Fig. 2 is a vertical view, chiefly in section, of a modified form of rectifying tube in which the dividing partition is of insulating material and the shell is connected to the cathode through resistance; and

Fig. 3 is a perspective view, partly in section, of another modification of a rectifying device.

The reference character 11 indicates a container or tube, usually of glass, having a stem 12 through which the leading-in wires for the electrodes may be carried. A cathode 13, preferably a hot and emitting body, is usually constructed in the form of a helically wound filament. The cathode may be of the Wehnelt type having a coating of a highly emissive substance such as barium, calcium or strontium or even of cæsium, rubidium or potassium which may be in the form of oxides, carbides, silicides or similar compounds or which may be in metallic form. Preferably provision is made for preventing or minimizing the disintegrating effects of the gas discharge on the cathode by associating with the foregoing substances an anhydride of an amphoteric hydroxide such as aluminum, zirconium, nickel or chromium oxide.

Disposed at opposite sides of the cathode 13 and close thereto is a pair of anodes 14 and 15 which are preferably made of carbon or graphite or of material having a negative temperature coefficient of heat conductivity. Mixtures of nickel and magnesium oxide may be mentioned as other materials having such properties. It has been found that such materials do not tend to have small spots or points of localized heating and disintegration to the same extent as do materials that have a positive temperature coefficient and they are therefore peculiarly adapted for use as anodes in the type of device shown wherein the currents and consequently the anode heating is greater than usual. A shell or small chamber or capsule 16 substantially spherical, provided with a plurality of holes or openings 17, surrounds the anodes and cathode and also has a partition or screen 18 which divides the space within the shell or chamber into two compartments. The partition 18 has an opening 19 in which is positioned the cathode 13. It will be seen that the anodes are separated from each other and each is positioned in a compartment of its own and any discharge path between the anodes passes or lies substantially through the negatively charged region of the hot and emitting cathode 13. The shell 16 and the partition 18 may be of sheet nickel or of other suitable electrically conducting material. The tube 11 is filled with one of the rare gases or such other gas, as nitrogen or hydrogen which does not have any appreciable action on the materials of the cathode; or the gas filling of the tube may consist of a mixture of such gases.

A suitable supporting bracket 20 of conducting material may be attached to the shell 16 and have its lower end carried by the glass

stem 12. The cathode has one end thereof connected to the conducting partition 18 as at 22 and the other end of the cathode is connected to the other leading-in wire 23. A suitable insulating bushing 24 is provided for the leading-in wire 23 where it passes through the shell 16. A leading-in wire 25 is connected to the anode 14 and is protected by a small insulating tube 26 throughout its length from the glass stem 12 through the shell 16 to the anode 14. It is desirable that the substance from which the tube 26 is made should be such as to be free from danger of cracking or disintegration under great temperature changes, as for example, zirconium glass, steatite, burned zirconium oxide, beryllium oxide, porcelain, quartz or a combination of such materials. It is also desirable, because of the high temperature to which it is subjected, that the graphite of the anodes should come in contact only with such materials as will not be reduced by the graphite as zirconium oxide or beryllium oxide. The anode 15 also has a leading-in wire 27 with a similar insulating tube 28.

In operation the anodes and cathode are connected in the usual way to an alternating current circuit and the current flows first from one anode and then from the other to the cathode, there being no current flow from the anode having a negative potential with respect to the cathode. The compartment which is carrying current has only a moderate potential difference between the anode and the cathode and the current flows in the direction of this potential difference, the rest of the potential difference being absorbed in the load circuit. In the meantime the full potential difference exists between the anode of the opposite compartment and the cathode but without current flow. Under certain conditions of ionization this results in a tendency to a breakdown arc between the anodes. By the arrangement of parts shown any flow of current from anode to anode is compelled to pass through the region adjacent to the cathode. As this region is negatively charged, that is, the electrons and negative ions are in excess of the positive ions, it is practically impossible for such short circuits between the anodes to take place nor is it necessary for the glowing cathode to completely fill the opening in the partition as the negatively charged region extends to some distance away from the cathode.

One of the advantages of the disposition of the parts is in the heat conservation, the shell preventing heat losses both of radiation and of convection currents. By thus concentrating the discharge within a small space and making the discharge path a short one the voltage drop in the discharge path and the corresponding heat losses are made small. By shielding the anodes from each other and preventing breakdown therebetween it is possible to rectify higher voltages and because of the short distance between the electrodes it is possible to operate at higher current densities so that the total capacity is increased in two ways, voltage and current. Under conditions of operation involving considerable heating it may be desirable to provide means for dissipation of the excessive heat such as the openings or perforations 17. The lower voltage drop through the discharge path also results in a lower maximum velocity of ions and consequently in less disintegration of the cathode due to ionic bombardment.

Another advantage of the invention is the prevention of wall charges on the inside of the tube 11. When wall charges exist on the inside of the tube the discharge becomes sensitive to outside influences and is somewhat unstable. Also there is an energy loss due to the ions and electrons neutralizing each other on the wall. Such charges are deposited on the capsule or shell 16 and in the arrangement shown in Fig. 1 are led away by means of the connections to the cathode. The operation of the tube is therefore rendered more stable and the energy losses due to wall charges are reduced.

In the modification shown in Fig. 2 the shell or capsule 16*a* is not an exact sphere but somewhat cylindrical. The partition 18*a* has an outer portion 29 of insulating material such as zirconium oxide. In the inner portion thereof there may be, if desired, embedded a metallic plate 30. The partition 18*a* may be supported on the shell 16*a* by means of an annular ridge 31 which need not extend all the way around but may be omitted on the under side where the leading-in wires and supports are close together. The chief advantage of the embedded metallic plate is the opportunity which this affords for de-gassing during manufacture by the heating of the plate by means of high frequency eddy currents, although the plate also renders the partition somewhat stronger mechanically. The structure of Fig. 2 is also different in the manner in which the two parts of the shell 16*a* are each connected through the supporting brackets 20 to the cathode leads 21 and 23. The connection is made through a resistance 32 which may be positioned in the recess 33 usually provided in the lower portion of the stem. By suitable changes in the resistance 32 the potential of the shell 16*a* may be brought as close as desired to the potential of the cathode 13. In some cases, particularly where the heat dissipated in the resistances is high, it may be preferable to place the resistances outside the stem as in the base or elsewhere. It is to be understood that any of the features of construction shown in Fig. 2 may be employed in Fig. 1 and conversely.

In the modification shown in Fig. 3 the inclosing shell or capsule 16*b* comprises a woven

wire structure or screen which permits the dissipation of excessive heat under conditions of heavy load. In this case there are three anodes which make the device especially adapted for rectifying three-phase currents. The dividing partition 18*b* comprises three wings 34, 35 and 36 which are preferably spaced at equal angles from each other and together with the shell 16*b* form three compartments in which are positioned the three anodes. In this modification the partition is of metal as in Fig. 1, but the partition is not connected to the shell but spaced therefrom as indicated at 37 and 38.

It is to be understood that the above embodiments of the invention are for the purpose of illustration only and various changes may be made therein without departing from the spirit and scope of the invention as defined in the subjoined claims.

I claim:

1. A gas filled rectifying device comprising a tube, a heatable cathode positioned therein, a pair of anodes disposed on opposite sides of the cathode, and a small inclosing shell surrounding said cathode and anodes and having a partition separating the anodes, said partition having an opening in which is disposed the cathode.

2. A gas filled rectifying device comprising a tube, a heatable cathode positioned therein, a pair of anodes disposed on opposite sides of the cathode, and a small inclosing shell surrounding said cathode and anodes and having a partition separating the anodes, said partition having an opening in which is disposed the cathode, the shell and the partition being in electrical connection with the cathode.

3. A gas filled rectifying device comprising a tube, a partition therein dividing the tube into a plurality of compartments and having an opening therein, a heatable cathode positioned in said opening, an anode positioned in each of said compartments, and an inclosing wall around each anode to inclose said anode with the cooperation of the partition and cathode, said wall having means for the dissipation of heat therethrough.

4. A gas filled rectifying device comprising a tube, a partition therein dividing the tube into a plurality of compartments and having an opening therein, a heatable cathode positioned in said opening, an anode positioned in each of said compartments, and an inclosing wall around each anode to inclose said anode with the cooperation of the partition and cathode, said wall having a plurality of openings therein for the dissipation of heat therethrough.

5. A gas filled rectifying device comprising a tube, a heatable cathode therein, a pair of anodes disposed on opposite sides of the cathode, and an inclosing shell surrounding said cathode and anodes and having a partition separating the anodes, said partition having an opening in which is disposed the cathode, said shell having means for the dissipation of heat therethrough.

6. A gas filled rectifying device comprising a tube, a heatable cathode therein, a plurality of anodes, and an inclosing shell surrounding said cathode and anodes and having a partition separating the anodes, said partition having an opening in which is disposed the cathode, said shell having a plurality of openings therein for the dissipation of heat therethrough.

7. A rectifying device comprising an envelope, a plurality of independent anodes, a common cathode therefor interposed in a path substantially directly between said anodes, and an insulating barrier between said anodes said barrier having an aperture in which said cathode is disposed.

8. A rectifying device comprising an envelope, a plurality of independent anodes, an insulating barrier interposed between said anodes, the ends of said barrier extending beyond the ends of said anodes to substantially isolate said anodes from each other, said barrier having an opening, and a cathode common to said anodes positioned in said opening.

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