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L. S. BAKER

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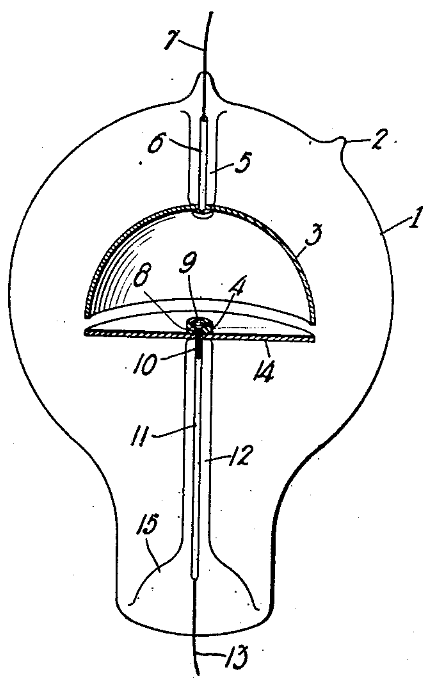
ELECTRONIC DEVICE

Filed Oct. 7, 1925



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UNITED STATES PATENT OFFICE.

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ELECTRONIC DEVICE

Application filed October 7, 1925. Serial No. 61,016.

This invention relates to new and useful improvements in electronic devices, and particularly to current rectifiers in which the electrodes are provided within an exhausted or gas-filled envelope.

It is the object of the present invention to provide a rectifier which efficiently operates for a long period of time, has a large current output, and which is yet inexpensive and simple to construct and operate.

The various features of the invention will be disclosed as embodied in a rectifier in which an aluminum and a carbon electrode are enclosed in a glass vessel filled with neon. However, it will be obvious to those skilled in the art that some of the advantages of the present invention may be attained also in other combinations and that certain features of the invention are applicable to other types of electronic devices or valves than the one herein disclosed without departing from the spirit of the invention as defined in the appended claims.

In the drawing, 1 is a glass envelope which may be exhausted at 2. Within this envelope are provided two electrodes, a substantially hemispherical aluminum electrode 3 which functions as the cathode, and a carbon electrode 4 which functions as the anode. The cathode 3 is firmly held against a glass or other suitable arbor 5, which projects downwardly from the top of the envelope 1, by means of a headed rivet 6 embedded in the arbor. A suitable leading-in wire 7 connected with the rivet 6 affords outside connection with the cathode.

The carbon electrode 4 is axially perforated at 8, the perforation ending in a recess 9 in the top surface of the electrode. A headed rivet 10 of thin aluminum wire is passed through the perforation with the head seated in the recess 9 below the top surface of the anode. The lower end of rivet 10 is frictionally held in a rod 11 which, with its leading-in wire 13, are embedded in an upwardly projecting arbor 12 and seal 15. A circular disc of mica 14 is clamped between the anode and the upper end of the rod 11, the disc being perforated to permit passage of rivet 10. The anode and cathode are placed adjacent to each other in or near the center of the envelope 1.

When the electrodes are connected in any suitable manner with a source of alternating current, the device will act as a rectifier. I have found that best results are obtained with an aluminum cathode because this material does not readily "sputter." For the purpose of focusing the bombardment on the carbon anode, the most advantageous arrangement found is the one herein disclosed in which the aluminum cathode is spherical in shape and the carbon electrode is located at or near the center of the sphere.

Various grades of carbon or other materials which do not readily sputter may be used as anodes. However, best results were obtained with carbon anodes manufactured in accordance with the following process: suitably calcined petroleum coke is mixed with coal tar pitch while heated to the consistency of a very stiff dough. This dough is compacted into the desired form under high pressure (in the nature of 7,000 pounds per square inch), through a small orifice. The resultant rods are cut in convenient lengths and heated in a nonoxidizing atmosphere to a very high temperature (in the nature of 1,000° C.) for several hours.

An important function of the disc 14 is to act as a shield for the glass rod 12 supporting the carbon anode. The disc protects the glass from the sputtered metal. Bombardment of the glass by sputtered particles of metal destroys the glass seal and impregnates it with sufficient metal to make it conductive.

The mica disc seems to aid also as a third element in the focusing of the electrons on the carbon point. After the rectifier has been operated for a certain length of time, the mica disc becomes coated with sputtered metal. This takes place along with the electronic bombardment of the mica disc during the useful part of the cycle. The functioning of the device indicates that the disc 14 thus acquires a positive charge. It is my opinion that the flow of an exceptionally small proportional amount of reverse current may be explained by the fact that the mica disc carries a positive charge. During the reverse cycle this charge will tend to deflect positive charges towards the carbon point which is now at a negative potential. Owing to this, the travel of negative particles from the carbon to the aluminum electrode is retarded by a dense positive space charge around the carbon, and consequently the reverse current is materially reduced. During the useful part of the cycle, negative particles which otherwise would travel past the mica disc and impinge on the glass rod 12, will now be attracted by the positive charge on the disc. Since the carbon point is at a higher positive potential than the mica disc, such deflected negative particles will probably reach the carbon electrode.

The above outlined theory of operation is borne out by measurements which indicate that throughout the useful and reverse cycles, the mica disc remains positively charged. This indicates that negative particles could not reach the mica disc in appreciable quantities. It is possible also that the mica disc functions as a mechanical means for focusing the electronic bombardment.

While a mica disc was found best suited for the present purpose, it will be obvious to those skilled in the art that some or all the advantages may be obtained with other materials or constructions without departing from the spirit thereof. If other than insulating material is used in this disc, then it should be insulated from the carbon electrode.

The electronic emission of the aluminum electrode may be increased by coating it with potassium, sodium or the like. For this purpose the aluminum electrode may be covered with a solution of potassium iodide which dries in place. Under the action of the tube the compound disintegrates, some of the iodine settling in the cooler portions of the glass vessel while the potassium remains on the cathode. Owing to its photoelectric action, the potassium gives off negative charges during both cycles of operation, which again aids the useful and retards the reverse current. The potassium also acts as a "getter" to clean up the occluded gases.

The presence of oxygen, nitrogen, or water vapor, as well as of mercury vapor and cer-other gases and vapors, in the glass vessel favors the sputtering of the electrodes. On the other hand, neon is not particularly favorable in sputtering. The heavy sputtered particles are not easily turned from their original paths and carry with them negative charges which would otherwise reach the anode.

Helium is even more desirable than neon from this point of view. However, in view of the fact that the discharge must take place at a comparatively low voltage, it is essential that the gas be readily ionized, so that we may have both positive and negative particles present. Neon is more readily ionized than helium. Hydrogen is also unfavorable to sputtering, but it is likely to react with or be occluded by other materials present. In the present case, the use of a highly evacuated vessel in which pure electronic current is present, was avoided because it would require high operating voltage. In the rectifier forming the subject of the present invention, the voltage is sufficient to ionize any gas more or less readily, so that the high ionization potential of neon does not mitigate against this gas.

The pressure of the gas in the tube must not be so high that it stops the electrons almost immediately upon leaving the cathode. I have found by experiment that devices which show a brush-like glow all around the aluminum cathode are of little use as rectifiers. Such brush-like glow is characteristic of relatively high pressure tubes. On the other hand, the pressure must not be too low, for then the electrons will travel all the way from the aluminum to the carbon without striking any gas molecules and there may be no positive particles formed by ionization.

Occluded gases favor sputtering and they must be eliminated by baking or sweeping the tube, or by providing some suitable getter.

The end of the rivet 10, by means of which the carbon anode is held in place, must lie below the surface of the anode. If the end of this wire were in the plane of the anode surface, then the stream of electrons would tend to concentrate thereat, liberate the occluded gases and eventually destroy the wire.

The leading-in wires 7 and 13 should be provided at the greatest possible distance from each other so as to prevent arcing which, as well known, causes the destruction of the glass seal.

It will be obvious to those skilled in the art that the construction and proportions of certain elements, and the materials of which they are made, may be varied to suit operating requirements. Good results were obtained with a rectifier containing neon gas at around 8.5 mm. pressure. The shape of the glass envelope was substantially like that shown in the drawing. The diameter of the aluminum cathode 3 and the mica disc 14 was $1\frac{7}{16}''$. The carbon electrode 4 was cylindrically shaped with rounded edges and of a diameter of $\frac{3}{16}''$. A rectifier constructed in this manner and connected with a 120 v. alternating current source by means of a suitable transformer, delivered 40 milliamperes of direct current at a pressure of 90 v. for more than 3,000 hours without any reduction in the efficiency of operation.

What I claim is:

1. In a current rectifier, a gas-filled air-tight envelope, a hemispherical cathode in said envelope, a freely exposed anode in said envelope mounted at a point substantially equidistant from all points of said cathode, leading-in wires for said anode and said cathode at opposite points of said envelope, and an insulating disc of substantially the same diameter as said cathode held below said anode.

2. In a current rectifier, a gas-filled air-tight envelope, a hemispherical aluminum cathode in said envelope, a freely exposed

carbon anode in said envelope mounted at a point substantially equidistant from all points of said cathode, leading-in conductors for said anode and said cathode at opposite points of said envelope, a mica disc of substantially the same diameter as said cathode, and means including said anode and its leading-in conductors for centrally holding said disc below said anode.

3. In an alternating current rectifier, a centrally bulging glass envelope filled with neon at 8.5 mm. pressure, a hemispherical aluminum cathode near the center of said envelope, a perforated carbon anode centrally located and freely exposed with respect to said cathode and near the focal point thereof, a rivet for holding said cathode, a glass arbor depending from the top of said envelope and in which said rivet is embedded, another rivet through the perforation of said anode, the head of said other rivet being below the upper surface of said anode, a metallic rod holding the end of said other rivet, a glass arbor projecting from the bottom of said envelope and in which said rod is embedded, and a mica disc clamped between said anode and said last mentioned arbor, the diameter of said disc being substantially the same as the diameter of said cathode.

In testimony whereof, I have signed my name to this specification this 6th day of October, 1925.

LEWIS S. BAKER.