Oct. 31, 1950 D. B. CLARK 2,528,033

POWER RECTIFIER TUBE

Filed July 16, 1946

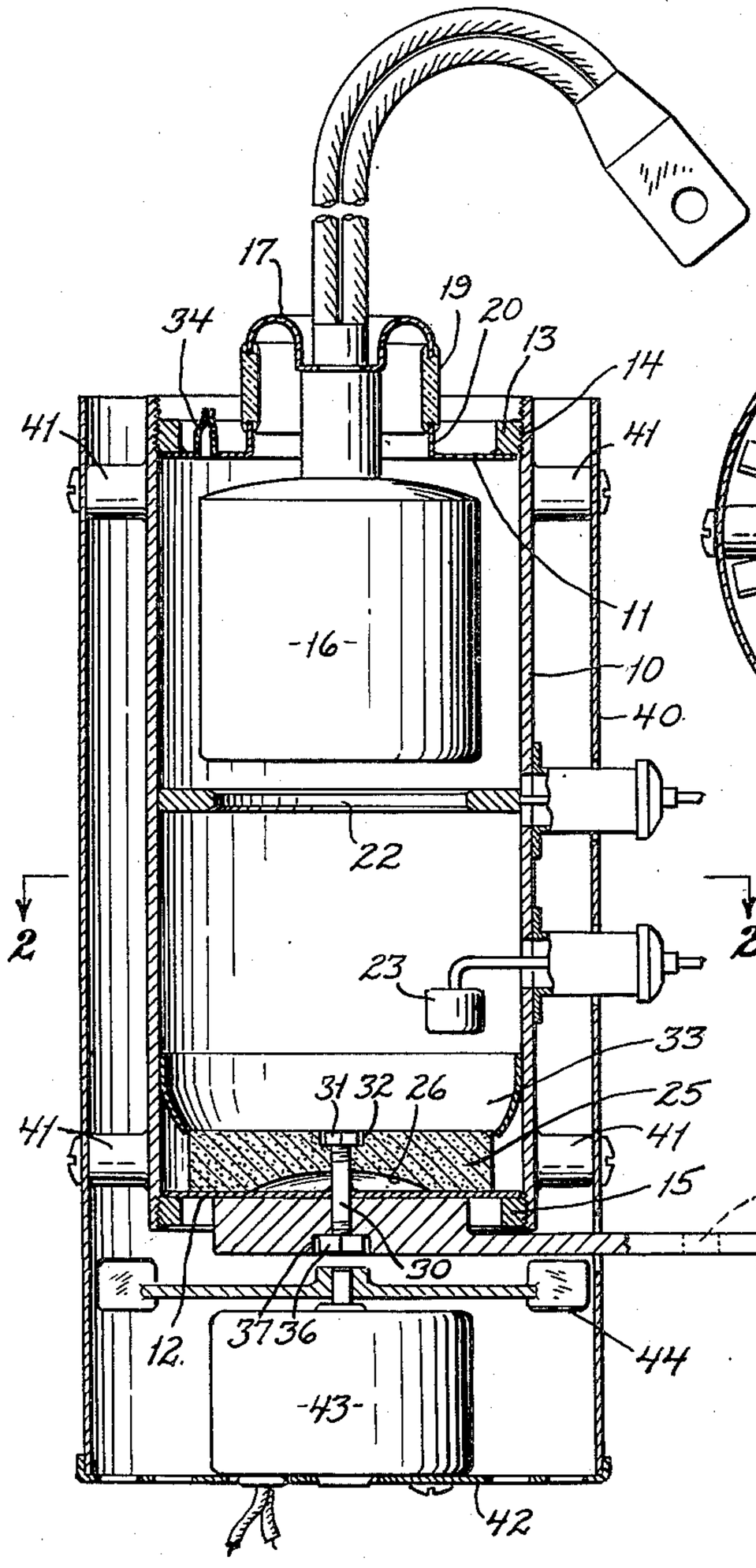

FIG. 1

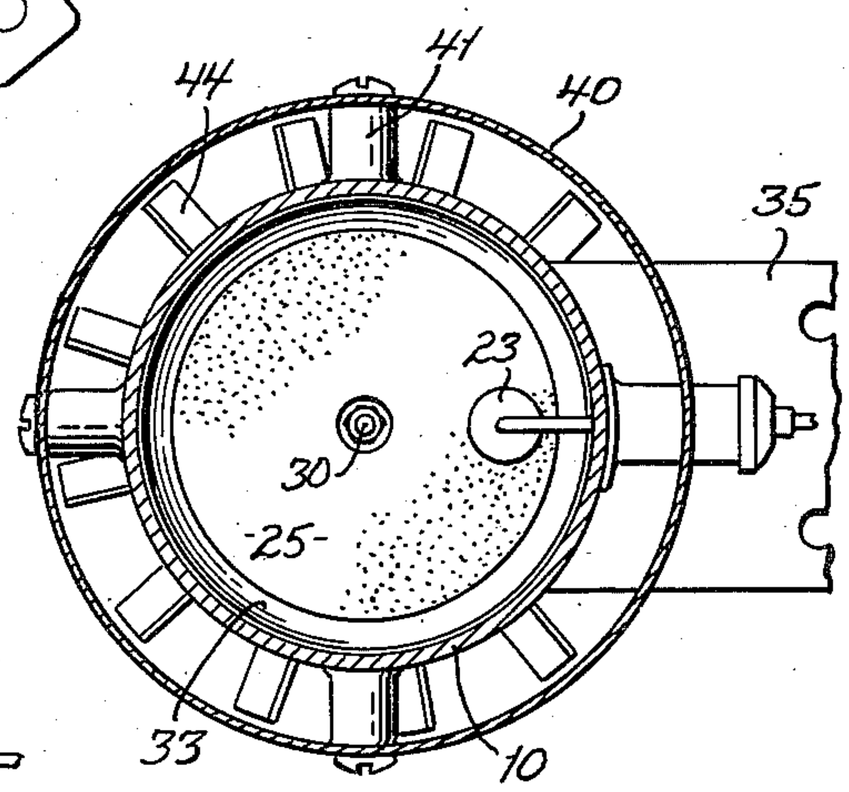

FIG. 2

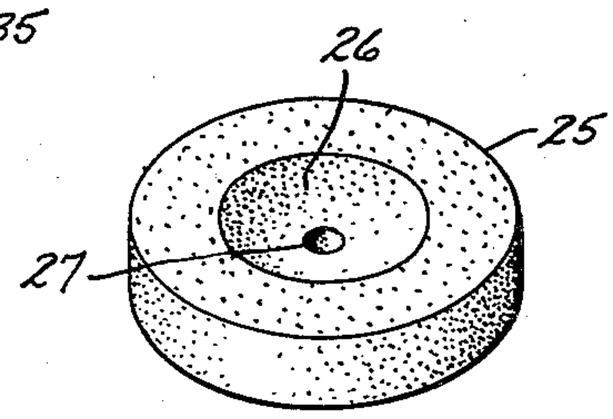

FIG. 3

INVENTOR.
DUDLEY B. CLARK
BY
Jay Jolrick & Jay
ATTORNEYS

Patented Oct. 31, 1950 2,528,033

UNITED STATES PATENT OFFICE

2,528,033

POWER RECTIFIER TUBE

Dudley B. Clark, Palm Springs, Calif.

Application July 16, 1946, Serial No. 683,808

14 Claims. (Cl. 250—27.5)

1

The present invention relates to a mercury vapor rectifier and more particularly to a cathode for such device and a method of producing the same.

One fault of the conventional mercury vapor rectifiers is that they are not suited for use in moving vehicles and boats because the mercury cathode will readily splash or otherwise change its position and cause failure of the rectifier.

An object of the present invention is to provide a cathode for a mercury vapor rectifier in which the mercury is absolutely prevented from splashing or changing its position in the rectifier whereby the rectifier may be subjected to sudden and violent movements without interfering with the operation thereof. Thus, the rectifier is quite suitable for use on moving vehicles and like environments.

Another object of the invention is to provide a method of forming a cathode for a mercury vapor rectifier, which cathode will provide the necessary mercury vapor for operation of the rectifier, but which retains the mercury in a relatively immobile form.

Other objects and advantages of the invention will be apparent from the following description of a preferred form of the invention, reference being made to the accompanying drawings wherein:

Fig. 1 is a vertical sectional view of a mercury vapor rectifier;

Fig. 2 is a view in section taken substantially on line 2—2 of Fig. 1; and

Fig. 3 is a perspective view of the cathode member of the rectifier, the member being shown inverted with respect to the position it normally assumes in the rectifier.

My invention consists in the provision of a porous, preferably disk-like member, which may be formed of any suitable material, and which member is capable of absorbing within it substantially the entire volume of mercury to be used in the rectifier. The body is saturated with mercury before it is placed in the rectifier, and it provides the requisite amount of mercury at the surface thereof for establishing operation of the rectifier and at the same time, there will be no free body of mercury which could splash or become otherwise displaced due to tilting or jarring of the rectifier and therefore backfire or failure in the rectifier from this common cause is obviated.

In certain types of rectifiers now in general use, the cathode is formed by a pool of mercury and the electrical contact between the cathode

2

and the wall and terminal of the tube is effected by surface conduction along the mercury. Since mercury offers a relatively high resistance, an appreciable amount of current is lost in the generation of heat, particularly in high power tubes rectifying large currents. In my improved rectifier, when the porous cathode is of metal, there is a large contact area throughout the body with the mercury and the contact of the body with the terminal effects a relatively good electrical contact and the heat generated by electrical resistance at the cathode is considerably less than for the pool type cathodes.

Referring now to the drawings I have shown certain parts of a rectifier for the purpose of illustrating my invention; the starting mechanism and circuits for the rectifier are not shown, but they may be similar to those disclosed in my copending application Serial No. 734,712, filed March 14, 1947, now Patent No. 2,468,037, dated April 26, 1949. The rectifier includes an inner stainless steel tube 10 closed by a top plate 11 and a bottom plate 12. The plate 11 is welded to a ring 13 and the ring 13 is threaded into the upper end of the tube 10. After the plate is properly positioned the threads are then welded as indicated at 14 so that a gas-tight seal is formed. The plate 12 is similarly attached to the lower end of the tube 10, the plate being welded to ring 15 which is threaded into the tube and welded therein as described with reference to the ring 13.

The usual type anode 16 is supported in place by a collar 17 that is bonded with the upper end of a glass collar 19 to form a hermetic seal therewith, and the collar 19 is carried on a central neck 20 formed on the plate 11 and is bonded thereto by a hermetic seal. In accordance with established practice, an annular deionization grid 22 is provided in the central portion of the tube 10, and an auxiliary anode 23 is provided below the grid 22.

The cathode for the rectifier, which is the novel feature of the rectifier, is formed of a disk-like porous member 25 which is supported on the bottom wall 12. The member 25 may be formed in any suitable manner. For example, it may be a disk-like porous, non-ferrous metal body similar to filter elements now commercially available. These members may be made by compressing powdered metal in a suitable mold to form a body of the desired shape, and then this body is sintered to bind the particles together. Such a body will be relatively porous so that it could be used as a filter for liquids. I prefer to form the body

of non-ferrous material, such as copper or a copper alloy, although it is to be understood that other materials, including ferrous metals and non-metals could be used. The under surface of the cathode member **25** is provided with a circular concave recess **26**, and when the member is in position in the rectifier a cavity is formed between the walls of the recess **26** and the wall **12**. The purpose of this cavity will be explained more fully hereinafter. A central opening **27** is formed through the cathode member for securing it in the rectifier, as will be more fully explained hereinafter.

After the cathode member **25** is formed, it is immersed in mercury in a pressure chamber and a pressure of at least 50 pounds per square inch is produced in the chamber. The chamber is then heated to a temperature of at least 200° F. until the member is completely saturated with mercury. The requisite amount of mercury to provide efficient operation of the rectifier will be retained within the member **25** by molecular attraction. As an example of the proper size of the member **25**, I have found that, for a rectifier capable of delivering 130 amperes average D. C. at 600 volts, a cathode member two and three-quarters inch in diameter and three-quarters inch thick is satisfactory.

The mercury impregnated member **25** is attached to the bottom wall by a bolt **30** which extends through the bottom wall **12** and is welded thereto. This bolt extends through the opening **27** and a nut **31** is threaded on to the bolt for securing the member to the bottom wall **12**. The upper surface of member **25** is counter-sunk at **32** to receive the nut **31** below the surface thereof.

Preferably, immediately above the edges of member **25** there is an annular deflector **33** attached to the tube **10** and arranged to direct condensed mercury collecting on the walls of tube **10** onto the member **25**.

A laterally extending cathode connector **35** is attached to the plate **12** by the bolt **30** and a nut **36** which is received in a counterbore **37** formed in the connector. Thus, the connector **35** is mechanically and electrically attached to the plate **12** and the cathode member **25**. The outer end of the connector **35** is provided with a pair of openings **38** by which the connector may be bolted to a suitable support which would also include a connection with the circuit in which the rectifier operates, but which are not shown.

After the cathode member **25** is in place, the tube **10** is evacuated by way of an outlet nipple **34** formed in the top wall **11**, and this outlet is then pinched off and sealed.

It is desirable to cool the tube **10** during operation of the rectifier and for this purpose I have shown a sleeve **40** surrounding the tube **10** and spaced therefrom by insulated spacers **41**. It will be observed that there is an opening between the upper and lower ends of sleeve **40** and the tube **10** so that an air passage is formed therethrough. On the lower end of the sleeve **40** I have provided a perforated support **42** on which is mounted an electric motor **43** for driving an air fan **44**. During operation of the rectifier the fan **44** draws air between the tube **10** and sleeve **40**, thereby providing a cooling action.

In operation, the mercury vapor rectifier is initiated by an igniter, not shown, but which is effective to form a cathode spot and initiate an election discharge between the porous cathode and either of the anodes desired or both. The rectifier then operates in the usual manner.

During operation, the vaporized mercury will condense on the sides of the tube **10** and it will flow downwardly and be directed onto the cathode member **25** by the deflector and be reabsorbed by molecular attraction.

The cavity formed by recess **26** and the bottom wall provides a pressure source when the cathode member **25** is heated from use which tends to force the mercury in that member to the surface thereof.

It will be apparent that the mercury in the rectifier will be completely contained in a relatively immobile form in the porous member **25** so that jarring and tilting of the rectifier will in no wise effect the operation thereof and yet, ample mercury will be available for vaporization to effect operation of the rectifier. Thus, as long as the rectifier is normally retained in an upright position, as shown, so that the vaporized mercury can condense and return to the member **25**, it may be intermittently tilted, jarred or otherwise displaced from its normal position without affecting its operation.

I have found that by forming the cathode member **25** of a metal that will amalgamate with the mercury, a more satisfactory electrical contact than is obtained in the conventional type rectifier will be effected. Furthermore, a mercury amalgam is equally as efficient as a liquid mercury cathode, as far as emission ability is concerned. Although non-metallic materials could be employed to form the cathode member, such members will not be as efficient as when a metallic member is used and more heat will be generated.

Other metals than mercury could be used for the cathode by impregnating such metal in a porous member. For example, zinc or lead could be used, but if used, they would have to be melted before ionization could take place. It is to be understood, therefore, that my invention includes the use of metals other than mercury and the claims should be so construed.

It will be apparent that by my invention an efficient, relatively simple rectifier may be provided which can be successfully used in environments in which other known types of rectifiers could not be utilized by reason of the liquid quality of the cathode.

Although I have described but one form of the invention, it is to be understood that other forms could be devised, all falling within the scope of the claims which follow.

I claim:

1. A mercury vapor recitifier comprising, a tube including a bottom wall member and a cathode supported on said wall member, said cathode being formed of a porous disk member saturated with mercury, one of said members having a recess formed therein for providing a mercury collection pool and pressure chamber between a bottom surface of the cathode member and the upper surface of the wall member.

2. A mercury vapor rectifier comprising, a tube including a bottom wall, and a cathode comprising a porous disk supported on said wall, said disk having a recess in the bottom surface thereof for forming a mercury collection sump and pressure chamber between the wall and said disk.

3. A mercury vapor rectifier comprising, a vertical tube; a cathode at the lower end of the tube, said cathode comprising a porous disk-like body having absorbed therein a body of mercury, the said mercury being substantially

the entire amount of mercury in the tube; and deflector means about the inner wall of said tube and above said cathode for directing mercury, condensed on the inside of the tube, on to said cathode.

4. A mercury vapor rectifier having substantially the entire mercury content of the cathode absorbed in a porous copper body.

5. A mercury vapor rectifier having substantially the entire mercury content of the cathode thereof absorbed in a porous copper alloy body.

6. A mercury vapor tube comprising an envelope, an anode in the envelope, a porous cathode in the envelope, said cathode having absorbed therein a body of mercury, the said mercury being substantially the entire amount of mercury in the envelope.

7. A mercury vapor tube comprising an envelope, an anode in the envelope, a porous disc-like cathode in the envelope, said cathode having absorbed therein a body of mercury, the said mercury being substantially the entire amount of mercury in the envelope.

8. A mercury vapor tube comprising an envelope, an anode in the envelope, a body of mercury in the envelope for providing mercury vapor; and a metallic porous cathode in the envelope having absorbed therein a body of mercury, the said mercury being substantially the entire amount of mercury in the envelope.

9. A mercury vapor tube comprising an envelope, an anode in the envelope, a body of mercury in the envelope for providing mercury vapor; and a porous, non-ferrous metallic cathode in the envelope having absorbed therein a body of mercury, the said mercury being substantially the entire amount of mercury in the envelope.

10. A mercury vapor tube comprising an envelope, an anode in the envelope, a body of mercury in the envelope for providing mercury vapor; and a porous disk-like body in the envelope capable of retaining substantially the entire body of mercury therein and having a recess therein beneath the top surface thereof.

11. A mercury vapor tube comprising an envelope, an anode in the envelope, a body of mercury in the envelope for providing mercury vapor; a porous disk-like body in the envelope capable of retaining substantially the entire body of mercury therein, said body having a recess in the undersurface thereof; and a plate closing said recess.

12. The method of forming a cathode for a mercury vapor tube which comprises immersing a porous body capable of retaining mercury therein by molecular attraction into a pool of mercury, applying a pressure in excess of atmospheric pressure over the pool of mercury containing said body and elevating the temperature of the mercury and body above atmospheric temperature.

13. The method of forming a cathode for a mercury vapor tube which comprises, compressing a quantity of powdered metal into a suitable shape, sintering the powdered metal to form a porous body, immersing said body into a pool of mercury, applying a pressure in excess of atmospheric pressure over the pool of mercury containing said body and elevating the temperature of the mercury and body above atmospheric temperature.

14. The method of forming a cathode for a mercury vapor tube which comprises immersing a porous body capable of retaining mercury therein by molecular attraction into a pool of mercury, applying a pressure of at least 50 pounds per square inch in excess of atmospheric pressure over the pool of mercury containing said body and elevating the temperature of the mercury and body to at least 200 degrees F.

DUDLEY B. CLARK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,218,386	Smith	Oct. 15, 1940
2,427,999	Winograd	Sept. 23, 1947
2,432,513	Depew	Dec. 16, 1947

FOREIGN PATENTS

Number	Country	Date
201,744	Switzerland	Mar. 1, 1939