P. C. HEWITT.

MERCURY VAPOR RECTIFIER.

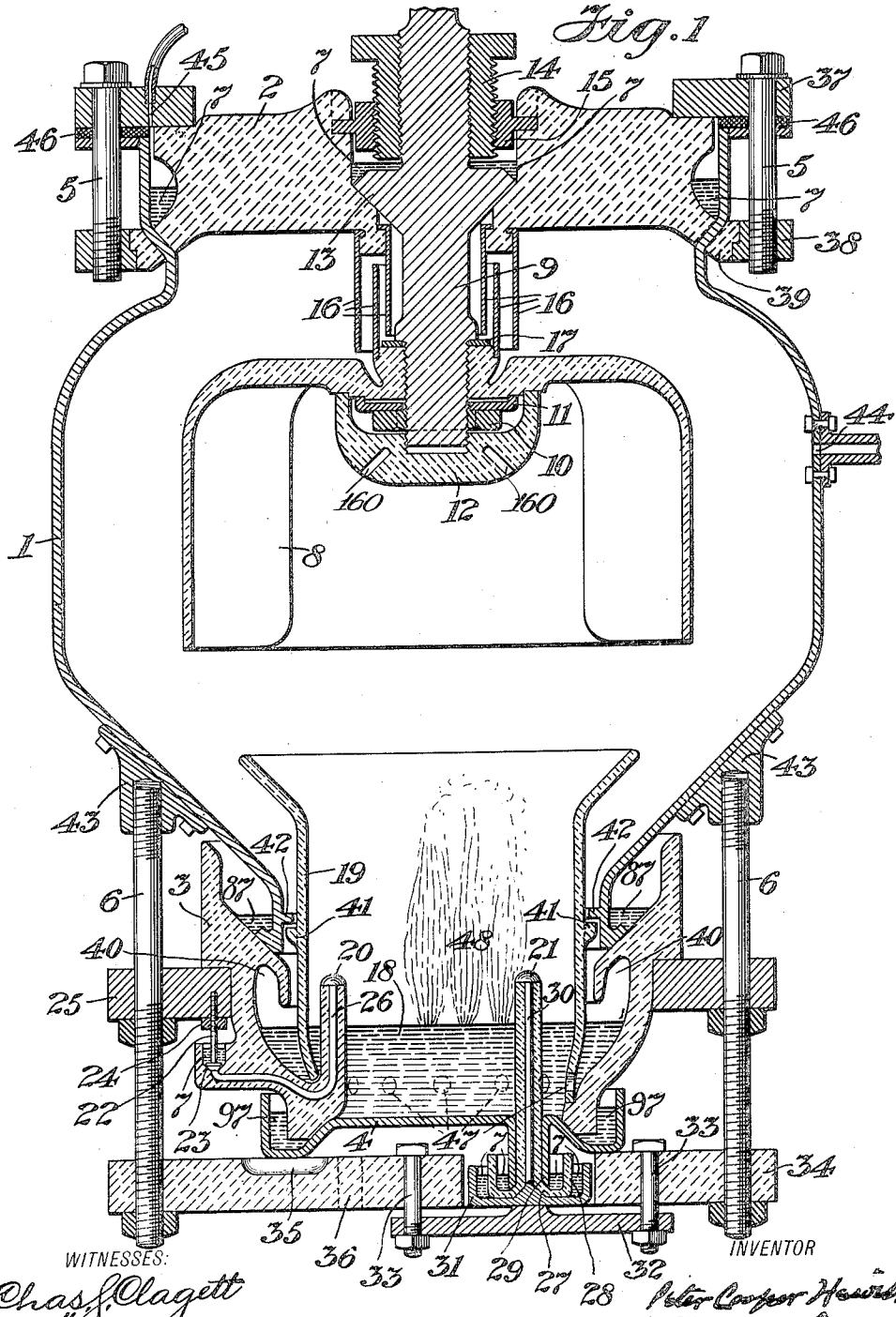
APPLICATION FILED JAN. 3, 1911.

1,110,557.

Patented Sept. 15, 1914.

2 SHEETS—SHEET 1.

Fig. 1



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2 SHEETS—SHEET 2.

Fig. 2

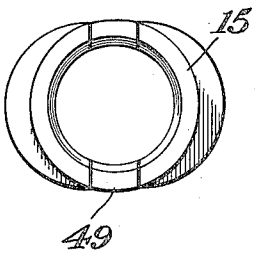


Fig. 3

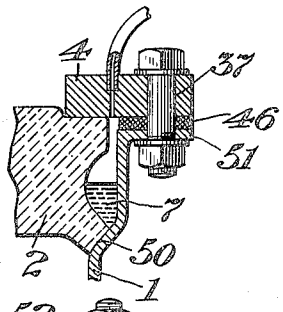


Fig. 4

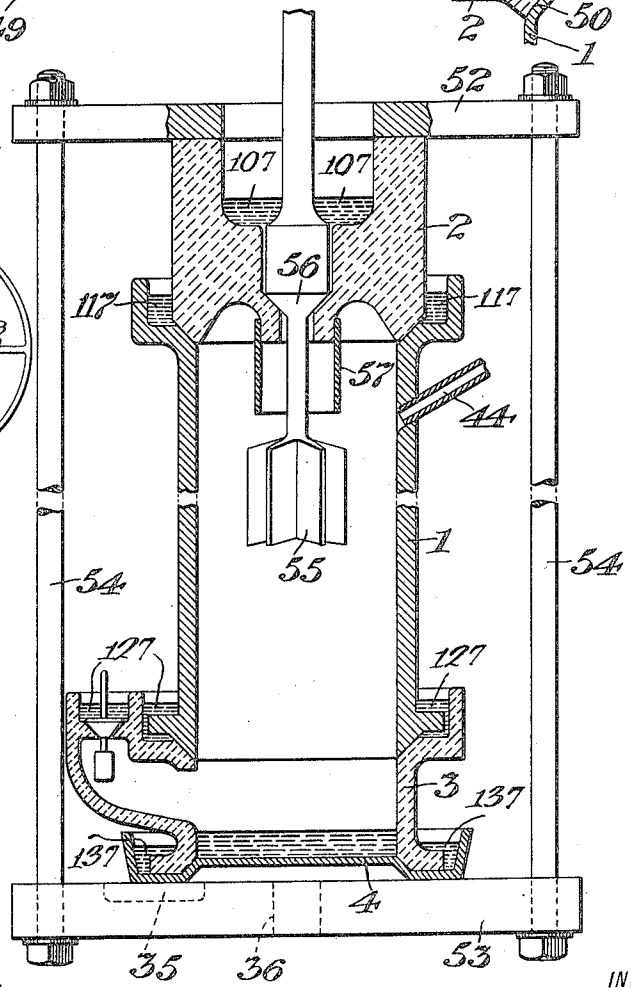
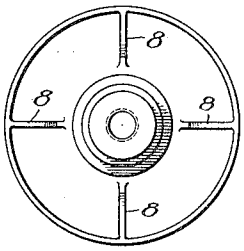


Fig. 5.



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UNITED STATES PATENT OFFICE.

PETER COOPER HEWITT, OF RINGWOOD MANOR, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO COOPER HEWITT ELECTRIC COMPANY, OF HOBOKEN, NEW JERSEY, A CORPORATION OF NEW JERSEY.

MERCURY-VAPOR RECTIFIER.

1,110,557. Specification of Letters Patent. **Patented Sept. 15, 1914.**

Application filed January 3, 1911. Serial No. 600,443.

To all whom it may concern:

Be it known that I, PETER COOPER HEWITT, a citizen of the United States, and resident of Ringwood Manor, county of Passaic, State of New Jersey, have invented certain new and useful Improvements in Mercury-Vapor Rectifiers, of which the following is a specification.

The present invention relates to rectifiers and more particularly to such rectifiers as are suitable for handling large volumes of current. The rectifiers described herein may be utilized on alternating supplies of any number of phases.

In the case of mercury vapor rectifiers adapted to heavy current conditions special attention has to be given to such matters as leading in conductors both as to conveying them through the walls of the container and as to connecting them to the electrodes electrically; disposing of the generated heat; maintaining the positive electrode within proper temperature limits; preventing short circuiting; properly controlling the cycle of evaporation; securing and maintaining control of the condensation and return of the mercury; cooling the negative electrode; protecting the walls of the vessel in the neighborhood thereof; maintaining the vacuum and so on. It is to providing for such and similar conditions that my present invention is directed. The application refers more specifically to a rectifier for one phase or one impulse of the heavy current circuit, very similar rectifiers being used for other supply impulses. Accordingly the device here shown as a rectifier may be regarded as an electric valve controlling one phase of a supply system. This is not intended to exclude the duplication or multiplication of the anodes in a given vessel whereby more than one phase is made subject to control.

It is characteristic of this invention that it discloses the structural features of a composite mercury arc container and connections to the cathode pool thereof.

In the apparatus illustrated in the drawings the main positive electrode is maintained separate from and inside the case or container.

The special features of the invention will, however, appear from the description which follows.

In the drawings, Figure 1 shows in vertical section a rectifier adapted to use an extra heavy current and illustrating the valve of simple rectifier form; Fig. 2 shows a detail of a split ring or anchor used in the apparatus of Fig. 1 for holding the positive electrode; Fig. 3 shows a detail of the mercury seal at the upper portion of Fig. 1; Fig. 4 shows a modified form of simple rectifier; and Fig. 5 is a view of the anode 8 and its connected parts, looking from below.

In Fig. 1, 1 is the main body portion of the container of a rectifier, and is circular in horizontal section, but of varying diameter; as shown this part is preferably of metal; 2 is a disk of insulating material, for example porcelain, filling the upper opening of the body piece 1; 3 is an insulating section or belt or ring piece, which may be of porcelain, forming part of the container and serving to separate and insulate the base cap 4, which is of metal, from the body portion 1. These various parts are held together by bolts 5, 5 at the top and 6, 6 at the bottom, the joints being made tight by grinding and the use of a mercury or other seal. Examples of such seals are shown at 7, 87 and 97.

The main anode 8 may be of graphite, iron or other metal or any conducting substance having the requisite refractory character and not chemically active. As shown, it is in the form of an inverted bowl with internal ribs, this form giving a large exposed anode surface. This anode is supported upon a center shaft or stud 9 of iron, copper or other suitable material which serves for a leading in conductor. The anode 8 is held to the shaft 9 by the nut 10, which bears on a washer 11; the nut 10 and the washer 11 being protected from electrical influence by the cap 12, of the same material as the anode 8, or of other suitable material. The cap 12 and the anode 8 have holes or grooves 160, 160, provided in the thicker portions, to facilitate the elimination of gases contained in the body of the material. The shaft or stud 9 is provided with a conical portion 13, bearing on a closely fitted or ground surface in the porcelain piece 2. The upper portion of the stud 9 carries a nut 14 threaded thereon, which nut forms the male thread of the anchor piece 15, which is threaded on the inside. The internal and external threads on the nut 14 are of different pitch, so that turning the

nut 14 in one direction forces the stud 9 against the porcelain piece 2, while motion in the opposite direction retracts it.

To prevent the formation of a cathode spot on or near the stud 9, where it is exposed above the anode 8, I may use shielding pieces 16, 16, 16, which are supported alternately from the disk 2 above and the anode 8 below and form a circuitous narrow passage from the free current space above the anode 8 to the surface of the stud 9. These shielding pieces may be of conducting or of insulating material, usually, preferably, of conducting material. I consider it often advantageous to apply a thick washer 17 between the shoulder of the stud 9 and the anode 8. It is well to make the thread on the lower end of the stud 9 a tight fit with the corresponding thread in the hub of the anode 8, and to provide large surface thereon for purposes of high joint conductivity.

The cathode 18 is constituted of mercury held by the insulating section 3 and the base cap 4, which latter thus may constitute the lead to the cathode, a cable or strap being readily bolted thereto externally.

In the operation of devices of this character it is usually important to prevent the so-called cathode spot from coming in contact with the edge of the cup confining the mercury of the electrode. Should this happen the cathode spot may climb up upon the internal surface of the wall where this is dirty or contains condensed mercury, in which case, the apparatus will become extinguished, or in the case of metal walls, it may attack the metal, thus deteriorating the condition of the apparatus. Mercury may appear on the walls of the container inside in such a way as to cause this difficulty either through condensation or from spattering from the cathode, or from mercury condensed above and running down. To avoid this phenomenon I utilize the sleeve or ring piece 19, which is of insulating material, and dips below the surface of the mercury of the electrode 18 and thus prevents the cathode spot from reaching the walls of the container.

In Fig. 1, are provided two auxiliary anodes 20 and 21, which serve to assist in keeping the rectifier alive, the lead of one passing through the body of the intermediate section 3 and terminating in the bolt 22, to which external connection may be made. This lead to the auxiliary anode is protected by a mercury seal 7 at the point 23. The bolt 22 is held tight on the seat of the joint by the nut 24 threaded on the bolt 22 and pressing against the auxiliary ring 25.

The auxiliary electrode 21 is supported on the insulating, especially formed, tube 27 which terminates in a cup shaped portion 28, providing for a mercury seal with the hollow boss 29, which forms a part of the base plate 4. The lead 30 of the auxiliary anode 21 connects at the bottom with a cup shaped portion 31 which serves again to provide a mercury seal with the insulating cup 28 at 7 as shown. The external circuit is then connected to the part 31 in any desired manner. The parts 27, 28, 29 and 31 are held in close contact by the saddle piece 32, held by bolts 33 to the bottom plate 34.

The plate 25 and plate 34 are held by the bolts 6 under upward pressure so as to form tight joints between the parts 1, 3 and 4. Passages are left at 35 and 36 to provide cooling circulation to and from the lower surface of the base cap 4. The plate 37 and the second plate and split ring 38 and 39 serve through the bolts 5 to clamp the parts 2 and 1, the part 39 being split so that it may be removed by dropping the piece 38.

The reëntrant portion or cavity 40 in the insulating section piece 3 serves to prevent the formation of a continuous circuit from the part 1 to the cathode through draining mercury. The bosses 41 and the lugs 42, 42 are interlinked and serve to hold the sleeve 19 in position.

The bolts 6, 6 are threaded into bosses 43, 43, which in turn are bolted on to the body portion 1. At 44 is bolted on to the body portion 1 an outlet pipe communicating with the interior of the vessel through which the container may be connected continuously during operation to a suitable exhaust pump.

I have shown at 45 a pipe and passage for applying mercury to the mercury seal 7 between the piece 2 and the piece 1. This arrangement is highly satisfactory as the sealing mercury, if mercury be used, is duly protected from dirt and to some extent from oxidation in virtue of the washer 46 which closes the space between the plate 37 and the top flange of the part 1.

I find it of advantage where a particularly tight mercury seal is required to provide means for causing the mercury of the seal to wet the walls of the bodies forming the seal, for example by amalgamating metal surfaces or by plating with gold, platinum or other amalgamatable material, where one or both pieces are of insulating material. As another method I may alloy the mercury with tin so that the mercury will naturally stick to the solid walls.

The operation of the apparatus of Fig. 1 is in general as follows: Operation may be initiated by applying a high potential to one or both of the auxiliary anodes 20 and 21 by any suitable means, a number of which are well known, certain examples being described in my patents above enumerated. This high potential breaks down the initial starting reluctance of the cathode 18, whereupon it is free to receive current from any of the anodes of the rectifier. Operation

may be started by making a connection between one of the anodes and the cathode, as by agitating the mercury until it touches one of the auxiliary anodes. After starting it is necessary that a continuous flow of current be maintained in the cathode, which can be done in a number of ways, the necessary condition being an over-lapping series of current waves from two or more of the anodes. Such a permanent flow of current may be maintained by the two auxiliary anodes 20 and 21, in which case the cathode remains excited, whether the current flows from the main anode 8 or not. It is desirable in some cases, however, to use only one auxiliary anode, in which case the impulses from this anode and from the main anode will mutually overlap. The negative starting reluctance of the anode 8 is never overcome by reverse current, so that the device acts as a rectifier or valve, permitting the flow of impulses of one direction from the supply and suppressing those of the other. Similarly the auxiliary anodes 20 and 21 will permit flow of current in one direction only, namely, to the cathode within the container. If they be supplied from a direct current source they must be applied in this direction. If one or both of these anodes be supplied from an alternating source reverse impulses will be suppressed automatically.

In the supply of heavy currents through the main electrodes, large quantities of heat and vapor will be liberated at the cathode; heat will also be generated by the passage of current through the vapor space and at the anodes. This heat will be dissipated in various well known ways, the most effective as regards the heat in the vapor, being through the walls of the container where mercury will condense and run back to the cathode in separate discharges from time to time, in virtue of the formation of the sides of the container and notably the reëntrant portion 40, 40. Thus the metal body portion 1 will be kept out of electrical contact with the cathode 18. The heat to be dissipated from a solid anode will be partly radiated to the walls of the container and partly conducted away by the vapor, the former predominating strongly under certain conditions. The cathode may be also effectively cooled through the bottom cap 4, which is of metal and in contact with a circulating cooling fluid. I provide perforations 47, 47, 47, 47, for providing a free circulation of the mercury through the sleeve 19.

By forming the anode 8, as shown, with large surface and ribs, a free disposal of heat is secured and at the same time a robust and a physical structure that is easily treated. To counteract any tendency for current to flow upon the stud 9 at its lower end or the nut or washer connected thereto, I interpose the cap 12, which may be favorably of the same material as electrode 8, and which may, as shown, completely inclose these exposed parts.

The joints between the several parts of the container are here shown as maintained tight by means of mercury seals 7, 7, which consists of a mechanical joint between two parts, close enough fitted to prevent the entrance of mercury, as, for example by grinding, with a certain quantity of mercury outside which resists the tendency of the air to leak into the mechanical joint, especially when this mercury is made to wet the surfaces of the solid material near the joint.

By very carefully exhausting the apparatus and heating the electrodes and the container thoroughly before sealing off, it is possible to operate these devices without undue deterioration of the purity of the vapor space, but it will often be desirable to provide a permanent connection, as 44, for the continuous or periodic removal of accumulated gases by the agency of a suitable pump.

A number of the mechanical features of construction shown in Fig. 1 will be self-evident therefrom and their utility understood. It will be understood that the cathode spot 48, or cathode spots on large currents, may divide into several parts but is entirely confined to the surface of the cathode within the sleeve 19.

In Fig. 2 I show, the part 15 of Fig. 1 which is provided with lugs corresponding to slots in the porcelain piece 2 and a removable piece 49 by which the piece 15 can be entered, turned through the proper angle and provide resistance for the nut 14 in setting up the stud 13, the whole constituting in effect a bayonet joint.

Fig. 3 shows in an alternative form the mercury seal at the upper left hand portion of Fig. 1. Here a flange 51 at the top of the metal body part 1 is directly bolted to the cap piece 37 with the washer 46 between making a tight joint. This construction has certain advantages in simplicity and flexibility under certain circumstances over the other construction.

In Fig. 4 I show a modified form of simple rectifier with different form of mechanical construction. Here the several parts of the container, the porcelain cap 2, the metal body portion 1, the porcelain section 3 and the bottom cap 4 are clamped together between the top piece 52 and the bottom piece 53 by the bolts 54. This form has exceptional mechanical strength. Mercury seals, 107, 117, 127, and 137 are used throughout as in Fig. 1, as is also the pump connection 44. In this case the anode 55 is of somewhat different form than the anode 8, being composed of ribs or veins disposed through a vertical axis. The stud or shank

56 serves both as a mechanical support for the anode and as a leading in conductor therefor. The tube 56 which may be of insulating or conducting material serves to protect the upper exposed portion of the stud 57 from influences tending to break down its negative starting reluctance. In this rectifier but one auxiliary anode is shown, though any number desired may be similarly placed around the circumference of the porcelain section. This anode is in a chamber opening off the main chamber but free to receive current from the cathode. Ventilating passages 35, 36 are shown in the bottom piece 53 to provide for cooling the bottom plate 4.

The operation of Fig. 4 is similar to that of Fig. 1 in many particulars and it is not believed that it is necessary to go into further detail on this point.

Instead of porcelain for the insulating portions other materials having the requisite mechanical and insulating qualities may be used. In those cases in which a separate main anode is provided, the portions shown as insulated need not be strictly of metal, but of any material having the requisite gas tight quality and mechanical strength and heat conducting capacity.

I claim as my invention:

1. A container for mercury vapor apparatus comprising a cap perforated for a lead wire, a metal ring or section supporting said cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container.

2. A container for a mercury vapor apparatus comprising a cap piece perforated for a lead wire, a metal ring section supporting said cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section, and a metal base cap sealing said container, the said porcelain section being perforated.

3. A container for mercury vapor apparatus comprising a cap piece perforated for a lead wire, a metal ring-section supporting said cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section, a metal base cap sealing said container, and an auxiliary anode supported by said base cap and provided with means for making electrical connection therewith.

4. A container for a mercury vapor apparatus comprising a cap piece perforated for a lead wire, a metal ring-section supporting said cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container, in combination with mercury seals for hermetically sealing the joints between the cap-piece and the ring section and the metal base.

5. A container for a mercury vapor apparatus comprising a porcelain cap piece perforated for a lead wire, a metal ring-section supporting said porcelain cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container.

6. A container for a mercury vapor apparatus comprising a porcelain cap piece perforated for lead wires, a metal ring-section supporting said porcelain cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container, the last named porcelain section being perforated for entering the lead wire for an auxiliary anode.

7. A container for a mercury vapor apparatus comprising a porcelain cap piece perforated for lead wires, a metal ring-section supporting said porcelain cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container, the said metal base cap being perforated for entering an insulated leading-in wire for an auxiliary anode.

8. A container for a mercury vapor apparatus comprising a porcelain cap piece perforated for lead wires, a metal ring-section supporting said porcelain cap piece and adapted to transfer heat from within to without the container, a porcelain ring section supporting and insulating said metal section and a metal base cap sealing said container, in combination with mercury seals for hermetically sealing all joints between the cap-piece and the ring section and the metal base.

9. A mercury vapor rectifier comprising an exhausted container, said container being made up of a top portion ending at its lower end in metal, an insulating section, a bottom portion, an anode in said container and a mercury cathode in the lower portion thereof, in combination with a hollow stud integral with said insulating section, the top of said stud rising above the surface of said mercury cathode in combination with a supplemental anode exposed on top of said stud, the lead of said electrode passing through said insulating portion to exposure outside the container.

10. In a vapor rectifier, a suitable container including a hollow shell of metal or other good conducting material, a belt or ring of insulating material supporting the

said shell and a base piece insulated from the said shell by the said belt or ring.

11. In a mercury vapor rectifier, a suitable container, an anode and a mercury cathode therein and a base piece forming contact with the cathode in combination with an auxiliary anode located above the mercury cathode and provided with means for connecting the said auxiliary anode with the said external circuit through the said base plate.

12. In a mercury vapor rectifier, a suitable container, an anode and a mercury cathode therein, the latter being supported in an insulating belt or ring and a metallic cap giving contact with the said cathode, in combination with an auxiliary anode having a lead passing through the body of the intermediate belt or ring and means for connecting the said auxiliary cathode to the said external circuit.

13. In a mercury vapor rectifier, a suitable container including a hollow metallic body, a base piece of metal and an intermediate insulating belt or ring, the latter being provided with a reëntrant portion or cavity, thereby preventing a continuous circuit for condensed mercury from the metallic portion to the cathode.

14. A vapor rectifier for large currents comprising an exhausted container, an anode and a conducting liquid cathode therein, in combination with an insulating sleeve or ring extending below the surface of said cathode and to a considerable distance above said cathode, whereby the cathode spot is confined therewithin, together with perforations or a passage below the surface of the cathode from inside to outside of said sleeve.

15. A vapor rectifier consisting of a case, a positive electrode, a liquid negative electrode insulated therefrom and an insulating sleeve or cylinder projecting below and above the surface of the liquid, in combination with an auxiliary electrode located within said sleeve or cylinder.

Signed at New York in the county of New York and State of New York this 28th day of December A. D. 1910.

PETER COOPER HEWITT.

Witnesses:
WM. H. CAPEL,
THOS. H. BROWN.