C. O. BASTIAN.

VAPOR ELECTRIC APPARATUS.

APPLICATION FILED JAN. 27, 1913.

1,110,985. Patented Sept. 15, 1914.

2 SHEETS—SHEET 1.

Fig. 1

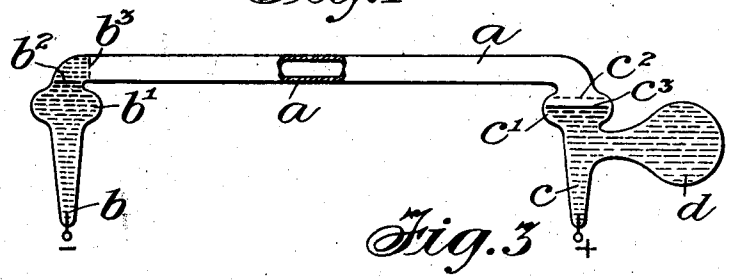


Fig. 3

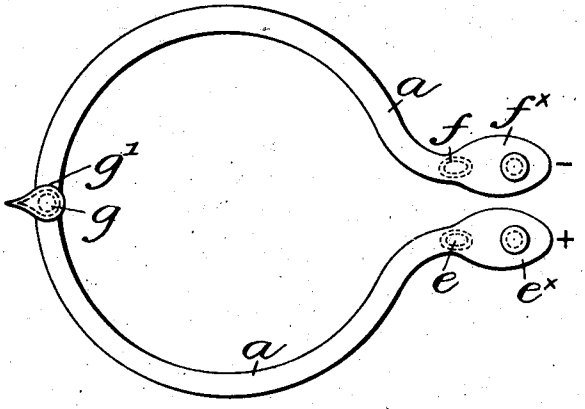


Fig. 2

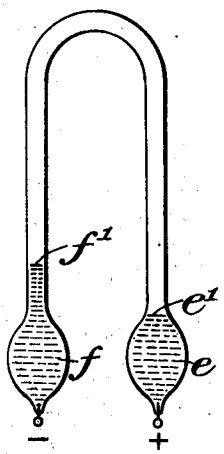


Fig. 4

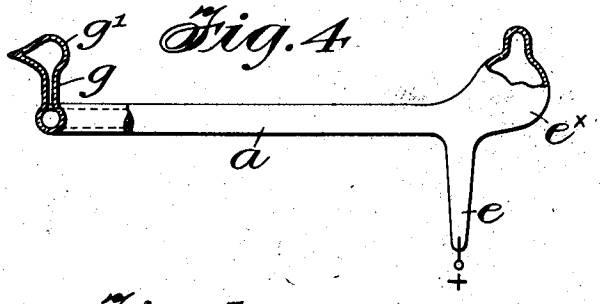
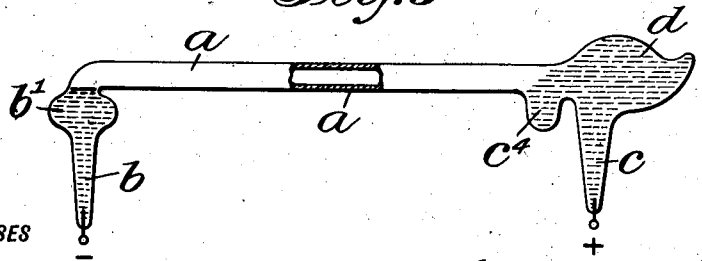


Fig. 5



WITNESSES

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2 SHEETS—SHEET 2.

Fig. 6

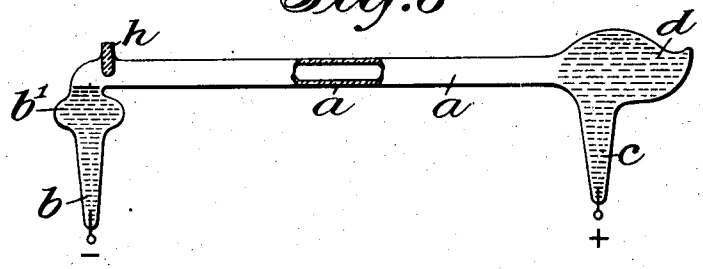


Fig. 7

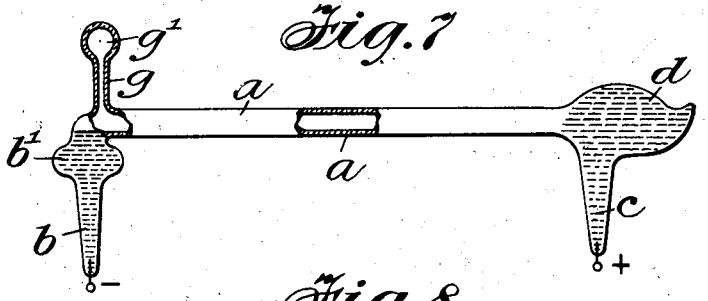


Fig. 8

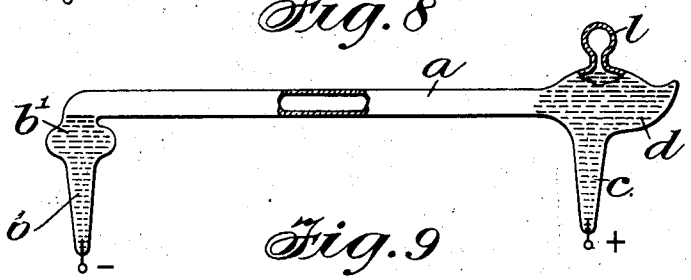
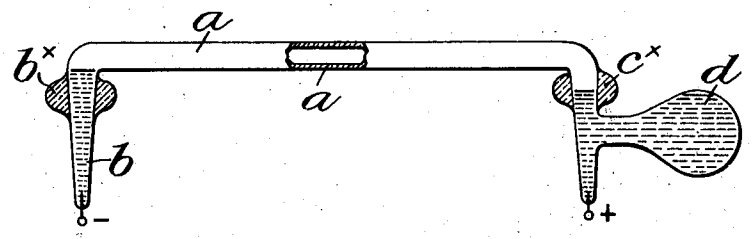


Fig. 9



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VAPOR ELECTRIC APPARATUS.

1,110,985. Specification of Letters Patent. Patented Sept. 15, 1914.

Original application filed December 19, 1905, Serial No. 292,480. Divided and this application filed January 27, 1913. Serial No. 744,306.

To all whom it may concern:

Be it known that I, CHARLES ORME BASTIAN, electrical engineer, a subject of the King of Great Britain, residing at 75 Bronsdesbury road, London, England, have invented certain new and useful Improvements in Vapor Electric Apparatus, of which the following is a specification.

This invention has for its object improvements in or relating to electric vapor apparatus especially electric lamps of the character known as "electric vapor lamps" or "vapor arc lamps."

For the sake of brevity I refer to the tube containing the mercury and electrodes and in which the arc is formed during working as the "burner" and this irrespective of whether the apparatus be used for giving light or for any other purpose such as rectifying or rupturing electric circuits. In such electric vapor apparatus—I have found that unsteadiness and accidental extinction of the arc may be caused by the passage through the arc path of particles or paths of unvaporized or un-ionized material, such as mercury, and I prevent this by forming the container tube at the upper or negative electrode of such small bore as to retain the unvaporized or un-ionized mercury within it and prevent it running down to the lower or positive electrode through the arc path, and I arrange the heat radiating surfaces and the cross-sectional areas of the positive and negative electrodes in such proportion one to the other, as to cause a higher temperature at one electrode than at the other, and a reduction of temperature at one electrode, as and when the volume of that electrode decreases or vice-versa, so that the evaporation of mercury from one and the condensation of mercury at the other, will automatically compensate for and rectify that increase or diminution, as the case may be due to that effect of the electric current which I may conveniently describe as a kind of electrolytic or ionizing effect.

Now by my present invention I retain practically constant quantities of mercury at each electrode respectively and thus establish and maintain a condition of equilibrium or practically so and thus secure perfectly steady working of my apparatus; as only mercury in a condition of vapor or in an ionized condition is permitted to pass through the arc path after the current has once been started (through the burner) and they consequently will keep constantly in operation with only a small proportion of steadying resistance for example sufficient steadying resistance to absorb only 15% of the total energy in the circuit.

When a symmetrical column of mercury is closely confined within (*i. e.* closely surrounded by) an exhausted glass tube of symmetrical bore, it exhibits a very considerable amount of cohesion throughout its length (even if held vertically or thereabout) and when it is desired to separate such column at any given point, it is advantageous to restrict the tube at that point *i. e.* render the column other than symmetrical at said point or otherwise make such point the weakest point in the column of mercury; for instance I may interpose a device or piece of glass or any suitable material or draw out the glass tube at the desired point to reduce the mercury cross-section and so render that point the weakest in the mercury column or I may produce this weakest point by providing a head of mercury at such point.

With all classes of mercury vapor lamps or other electric vapor apparatus it frequently happens that a small quantity of air or other gas remains within the container or occluded in the mercury after the lamp has been sealed, and taken off the pump but according to this part of my present invention I form or arrange in any suitable position on the lamp an enlargement or trap into which the air may be transferred by careful manipulation and retained there by solid mercury which latter may form one of the electrodes, and the air thus trapped is thereby prevented from getting into the arc and disarranging the normal operation of the latter. If the said enlargement or trap be attached to the top of the anode (or cathode) it serves the double purpose of a cushion for the mercury in such electrode forcing the mercury back when the circuit is broken and preventing it from sticking in the tube. When starting two or more of these burners in parallel by the "tilting method" I find it is practically impossible to cause both arcs to strike simultaneously which of course is necessary and I therefore strike one arc and then separate it or sub-divide it into two or more separate paths, and I may arrange this

for example by forming the tubular container Y-shaped with two positive electrodes and one common negative electrode, a chamber being provided at each of the positive ends of the burner for receiving the solid mercury removed from the arc path, and the bore of the tube may be suitably enlarged between the point at which the arcs unite and the negative electrode. I find it advantageous to fix the position of the negative electrode, and cause the mercury to move toward or past the positive electrode or electrodes, when the lamp is put into operation, and I maintain a constant length of arc between the electrodes, and cause the pressure within the arc to vary the position of the solid mercury situated in or moved into a suitable receptacle behind the positive electrode or electrodes; and solid mercury may be provided so as to keep the quantity of solid mercury at the positive electrode constant or approximately so.

The heat radiating surface of mercury vapor lamps or other electric vapor apparatus may be conveniently regulated by forming the glass or other envelop inclosing or surrounding the arc with a constant internal cross-section but with a thicker or thinner wall according to whether it is desirable to provide more or less heat radiating surface.

It has been proposed to start mercury vapor apparatus by means of a shunt electro-magnet, and to leave the latter in circuit during subsequent operation, but I find it desirable to arrange for the pressure within the arc to automatically cut out of circuit the shunt electro-magnet during such time as the lamp is in operation and to restore the connection when the current is switched off and the pressure subsides through cooling, and I may conveniently effect this by causing the pressure to act on a body of mercury behind the positive electrode as aforesaid for example by separating the electro-magnet circuit connection from the positive electrode.

Referring to the accompanying drawings:—Figure 1 is a diagrammatic view—in side elevation—partly in section of a burner showing the arrangement for producing differential heat radiating surfaces at the respective electrodes and varying cross-sectional area of the active electrode surfaces. Fig. 2 shows another form of burner namely a burner arranged as a U-shaped tube with an enlargement or bulb at each end of such U shaped tube. Fig. 3 shows another form of burner namely arranged approximately in a circular form with enlargement or bulb at each end of the circular container tube. Fig. 4 is a side elevation of Fig. 3—partly in section. Figs. 5 to 9 show various modifications and improvements in the type of burner shown in Fig. 1 as hereinafter more fully described.

Referring now more particularly to Fig. 1:—a is the container tube which is of small bore (as shown in section) adapted to retain the unvaporized or un-ionized mercury within it by the pressure of the arc stream and surface tension between said small tube and the mercury or otherwise prevent it passing through the arc path during the operation of the burner.

The electrode b (which I have marked as the negative electrode) is provided with an enlargement b^1 while the other electrode c (which I have marked as the positive electrode) is provided with an enlargement c^1 and also is provided with a bulb d for containing that part of the mercury which is displaced from the arc path when the burner is in operation.

Assuming that the burner is tilted until the mercury from the bulb d has filled the small bore tube a so as to complete the circuit from b to c and then the burner restored to the position shown in the drawings or thereabout (by electrically operated mechanism or any other suitable means) and thereby the burner put in operation the action is such that at the starting up of the burner the mercury in the enlargement c^1 will be at about the level shown in dotted lines at c^2 and the mercury at the negative electrode will be about the level shown by the dotted lines b^2.

By the action of the electric current throughout the operation of the apparatus mercury will tend to be transferred from the positive electrode to the negative electrode and consequently the mercury will tend to accumulate at the negative electrode up to say the level indicated at b^3 and simultaneously diminish at the positive electrode and as this proceeds eventually the level of the mercury at the positive electrode will descend in the enlargement c^1 to say the level indicated at c^3 at which point it will be obvious that a very much larger electrode surface is now presented than when said electrode was at the level c^2 and consequently the active electrode surface is brought so much the nearer to the general body of un-ionized mercury in the bulb d and thus an increased cooling effect on the electrode surface is obtained while at the same time the active electrode surface is increased and thereby the heat due to the passage of the current through the mercury at or near this surface is diminished with the result that the temperature of the electrode falls and prevents loss by evaporization or even causes gain by condensation. As the reverse action simultaneously takes place at the other electrode a state of equilibrium is established between the amount of mercury lost and gained by each electrode from whatever cause. Inasmuch as Fig. 1 illustrates the condition of the lamp during active operation,

the position of the negative electrode extending up to the level b^3 is justified, since the action of the current during this condition of the apparatus is sufficient to produce this result.

It does not follow that this point of equilibrium will be reached exactly at the level of the mercury indicated in Fig. 1 as aforesaid but if the burner be arranged so that the relative cooling effect be increased at one electrode as the mercury is transferred from that electrode then it will automatically arrive at the aforesaid point of equilibrium and thereafter continue so to operate. For example with a burner wherein the container tube a is of say three-sixteenths of an inch bore then the enlargement c^1 at the positive electrode c may increase from three-sixteenths of an inch up to five-sixteenths of an inch or more. By providing a similar enlargement b^1 at the negative electrode b this enables the burner to work with the current reversed.

In Fig. 2 the small bore container tube a is shown with enlargements or bulbs e and f practically of equal form and dimensions at each end of such U-shaped tube.

The quantity of mercury is advantageously such as to completely fill or rather more than fill each enlargement e and f when the lamp is tilted and in operation the mercury is gradually transferred from the positive electrode c so that the level of the surface of the mercury at the positive electrode gradually recedes toward or into the enlargement e at the positive electrode while the level of the mercury at the negative electrode f is gradually removed further from said negative electrode (for example as indicated in the drawings) until the point is reached that the mercury at the level f^1 becomes so much hotter than the mercury at the level e^1 that the equilibrium as mentioned above is established.

In Figs. 3 and 4 the small bore container tube a is shown arranged in a circular form or thereabout with a positive electrode e and negative electrode f each of the same size or approximately so with enlargements or bulbs e^x f^x located outside the path of the arc stream. In this arrangement the mercury lies right around the tube a (before the lamp is started) so as to normally connect the electrodes e and f and advantageously a small bore tube is used with sufficient mercury to normally fill said tube in order to connect the two electrodes e and f.

When the burner is started by tilting same the mercury is separated at or about centrally between the two electrodes and is caused to run back into each of the respective bulbs e^x f^x and the arc stream extends from or about the region of the electrode e around the circular tube to or near the electrode f.

As the mercury diminishes at the positive electrode e and accumulates at or near the electrode f the arrangement is such that similar action takes place as before described and the point of equilibrium is reached at which the respective levels of the electrode surfaces remain constant or practically so throughout the operation of the burner.

On the container tube a—and at about midway between the electrodes e and f—I arrange a small vertical tube g terminating in a bulb g^1 which is in closed connection with the interior of the said tube so that when the mercury is caused or allowed to pass around the container tube a to connect the electrodes e and f as aforesaid part of said mercury will be forced up the tube g and form a small head of mercury which (when the burner is tilted to start the same) will cause the mercury to positively divide at the point immediately below this said small column of mercury and thus insure starting the arc stream in the tube about centrally with respect to the electrodes and this insures the positive starting up of the burner in a regular manner. In the manufacture of these burners I find it advantageous to utilize this vertical column g and enlargement g^1 for the purpose of connecting to the vacuum pumps and the subsequent sealing off.

In the arrangement shown in Fig. 5—which is similar to Fig. 1 with certain modifications—the container tube a is shown straight with an enlargement b^1 at the negative electrode b and with a pocket c^4 near the positive electrode c. In place of the enlargement c^1 shown in Fig. 1 the bulb d for receiving the mercury is shown in a slightly different position to that of the bulb d in Fig. 1. The operation of this burner is similar to that already fully described with reference to Fig. 1 the mercury in the pocket c^4 producing a cooling effect at or near the positive electrode c.

Referring now to Fig. 6:—In this arrangement the enlargement b^1 as before is provided at the negative electrode b while no special enlargement (such as c^1 shown in Fig. 1 or such as the pocket c^4 shown in Fig. 5) is provided at the positive electrode c beyond the enlargement or bulb d which receives the mercury displaced from the path of the arc stream. h is a projection—advantageously glass—which extends into the bore of the tube a near the negative electrode so as to reduce the cross-section of the bore of said tube a at this point with the result that when the burner is tilted to start same this construction will insure the mercury always separating at the point h on starting up.

Instead of the projection h the tube a can be conveniently constricted by drawing the same out at any desired point; and the said

projection h or the said constriction can be placed or made at any suitable point.

Referring now to Fig. 7:—This shows a similar burner to Fig. 6 but in place of the constriction at h the tube a is provided with a vertical column g with enlargement g^1 at the top thereof same being in connection with the bore of the tube a so that when the mercury is caused or allowed to flow along the tube a to connect up the electrodes b and c part of said mercury will enter the said vertical tube g and form a column or head which when the lamp is tilted at starting will insure the mercury separating at the point just below said vertical tube g at the starting up of the burner in a similar manner to that described with reference to Figs. 3 and 4.

Referring now to Fig. 8:—In this burner is shown an enlargement b^1 at the negative electrode b while the enlargement at the positive electrode merges into the bulb d which receives the mercury displaced from the arc stream. In this arrangement this bulb d is shown provided with an upwardly extending chamber l which is in communication with said chamber d and the tube a; said chamber l being adapted to receive and retain therein any small quantity of air or gas which may be sealed within the burner which device l I may conveniently term the air trap.

Any air or gas present at any point in the burner can by shaking or otherwise be removed into this air trap or chamber l and thereafter when the burner is in operation and the mercury is forced back into the bulb d it will tend to enter said small chamber l and will consequently put any such air or gas in said air trap l under more or less pressure therein with the result that the return of the mercury from the chamber d into the tube a (when the burner is returned to its normal position upon discontinuance of current thereto) is facilitated. This air trap l may be placed if desired in any other convenient position on the burner *e. g.* it may be arranged at the negative electrode or at both electrodes.

Referring now to Fig. 9:—Instead of providing enlargements such as b^1 and c^1 at or near the electrodes as before described I may obtain similar or equivalent effect by providing an enlarged surface or mass such as the swellings or thickened glass walls $b^\times$ $c^\times$ as illustrated in Fig. 9; or these swellings may be formed of other suitable material or suitable portions of the surfaces may for the purposes hereinbefore described be prepared in any of the well-known ways either to reduce or to encourage radiation of heat. In this case advantage is not necessarily taken of increasing or diminishing the active electrode surface so as to moderate the temperature.

It will be obvious that if desired and where suitable the current may be passed in reverse direction through any of the burners illustrated especially in burners constructed in the manner described and illustrated in Figs. 1 to 4. Therefore mercury displaced from one electrode owing to the difference in electric potential between the electrodes can be replaced with mercury displaced in the opposite direction owing to the difference in heat potential between the electrodes and by constructing the burner so as to utilize this discovery I am thereby enabled to establish and maintain constant quantities of electrode material at each electrode respectively without the passage of solid mercury through the arc path.

In the following claims the terms "burner" and "mercury" are (for the sake of brevity) respectively used to denote and include any suitable device and any suitable electrode material as hereinbefore defined or explained.

This application is a division of my application Serial Number 292,480, filed December 19th, 1905.

I claim as my invention:

1. In a vapor electric lamp, a vapor tube having a positive and a negative mercury electrode, the tube having a diameter not exceeding the critical diameter at which the surface tension of mercury will be overcome by gravity when the tube is in its operative position.

2. In a vapor electric lamp, a vapor tube having a positive and a negative electrode of vaporizable material, the diameter of the tube and the surface tension of the vaporizable material serving to restrain the said material from flowing in a liquid condition through the tube.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES ORME BASTIAN.

Witnesses:

H. D. JAMESON,

C. P. LIDDON.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."