

P. H. THOMAS.
METHOD OF CONTROLLING VAPOR ELECTRIC APPARATUS.
APPLICATION FILED FEB. 9, 1904.

1,008,391.

Patented Nov. 14, 1911.

Fig. 4

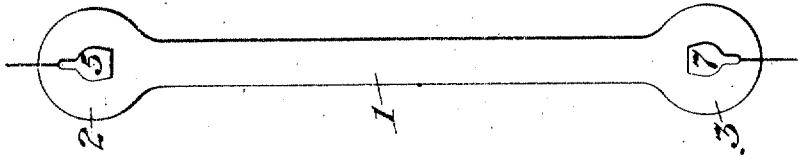


Fig. 3

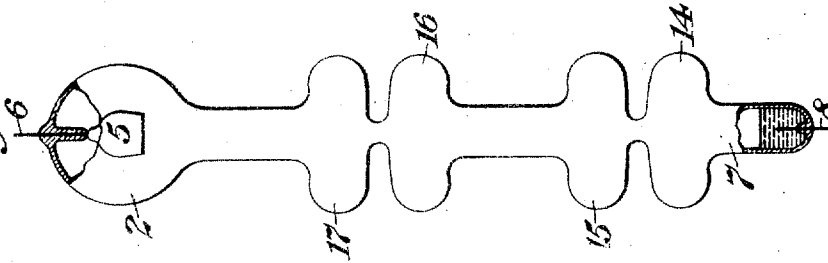


Fig. 2

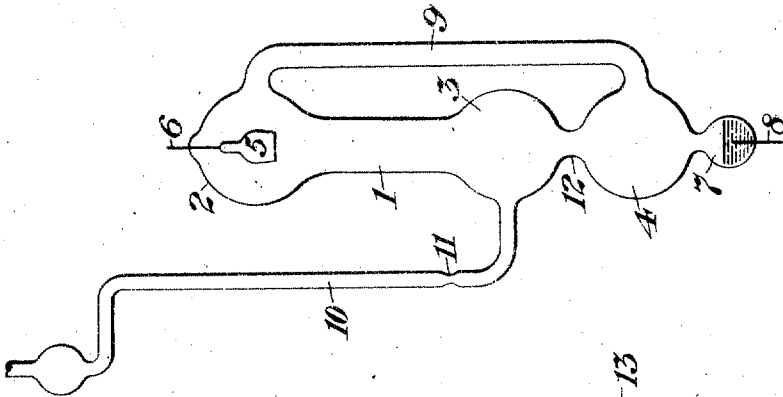
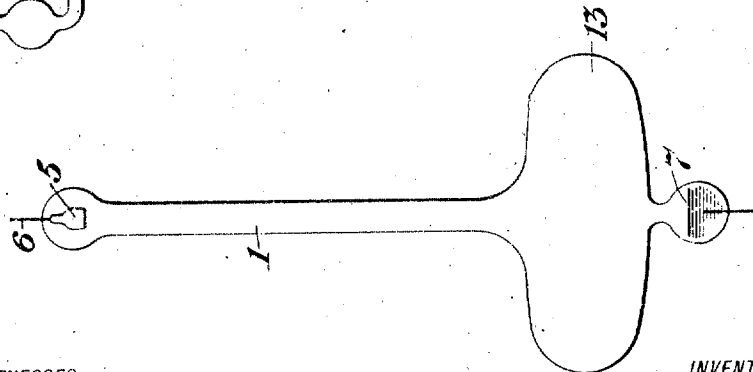


Fig. 1



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METHOD OF CONTROLLING VAPOR ELECTRIC APPARATUS.

1,008,391.

Specification of Letters Patent. Patented Nov. 14, 1911.

Application filed February 9, 1904. Serial No. 192,778.

To all whom it may concern:

Be it known that I, PERCY H. THOMAS, a citizen of the United States, and resident of East Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods of Controlling Vapor Electric Apparatus, of which the following is a specification.

The lack of red rays in the spectrum of the mercury vapor lamp is for some uses and purposes a serious disadvantage. On the other hand, the economy of the mercury vapor lamp is so great as to secure its adoption in places where the question of the color of the light is of minor importance.

Some of the simple and compound gases give spectra that contain an abundance of red rays when they are made luminous by the passage of an electric current. These gases, however, often require an expenditure of energy which renders their use in lamps practically prohibitive. A combination of the rays from mercury vapor and from some other gas might, however, afford an agreeable light and at the same time preserve reasonable limits of economy. The difficulty connected with employing some fixed or compound gas in combination with mercury vapor resides in the fact that without special care or special contrivances, the mercury vapor is liable to be generated in excessive quantities and crowd out the gases from the light-giving portion of the lamp. This is partly due to the fact that in the ordinary operation of mercury vapor lamps, a considerable amount of mercury vapor is naturally generated and that with lamps of the usual construction this vapor passes freely through all portions of the container. Another reason why the mercury vapor is likely to dominate other gases in the light-giving portion of the lamp is that the molecular or atomic weight of mercury vapor is very great in comparison with most gases and that when the natural mingling of the mercury vapor and other gases is disturbed, as by the discharge of an electric current, the lighter gas is likely to accumulate at one end of the lamp and to find difficulty in returning to the opposite end where it might mingle with the mercury vapor again. This tendency will be made clear by considering the following facts. Two gases are considered to be at the same temperature when, being separated by heat-conducting parti-

tions, one does not take heat from the other. Furthermore, two gases at the same pressure are known to contain the same number of molecules per unit of volume. From this it follows that two gases having the same temperature and pressure are composed of molecules moving at different velocities. Considering the mixture of two gases within a vapor electric apparatus, we may imagine that the current will be transmitted in the form of rapidly moving very small particles. These impinging upon the molecules of the gases cause them to give light. The particles will produce very different effects upon the small rapidly moving molecules of one gas from their effect upon the heavy molecules of the other gas, the result being a selective action by which the natural uniformity of diffusion of gases is disturbed, the lighter gases being forced to the more remote portions of the apparatus. The result will naturally be a difference in the relative quantity of light emission from what would be expected from their relative quantities. This matter may, of course, be looked at in a number of different ways and explained by other analogies. The above serves to elucidate the particular phenomenon referred to.

The present invention relates to means whereby the spreading of the mercury vapor through the body of the container is restrained to a certain extent and means whereby the lighter gas may be made to mingle with the mercury vapor at all times during the operation of the lamp. Such is the scope of the present invention as applied to the mercury vapor lamp.

In a still broader sense the invention contemplates the substitution for mercury as the disintegrating and reconstructible substance within the lamp, of a material such as molten tin, the molecular or atomic weight or the vapor pressure of whose vapor is considerably smaller than that of mercury vapor for which reason the tendency to resist the mingling therein of a lighter gas is less marked. Since the density of the vapor developed from molten tin is low, it thereby renders the distribution of the light and heavy gases easier. In other words, the invention contemplates using in a light-giving source gases or vapors which will more readily commingle than, for example, mercury vapor and the lighter gas. Should

nitrogen be selected as a fixed gas capable of developing red rays in combination with the characteristic rays of mercury vapor, the lighter gas might mingle more freely with the vapor of tin than it would with the vapor of mercury. The relative proportions of the vapors and gases within the lighting device may be varied by varying the temperature of the device. By reducing the temperature of the apparatus, the development of mercury vapor, for example, would be checked or made less copious, while by increasing its temperature the amount of vapor developed would be increased.

A still further adaptability possessed by the present invention is that it may be applied to the development of the peculiar spectra of various fixed or compound gases without the employment of a disintegrating reconstructible electrode. For example, with a negative electrode constituted of a material which does not harmfully exfoliate under the influence of current passing through a device of this character, a gas, such as nitrogen, might be utilized as the sole medium for carrying the current through the device; or a mixture of gases calculated to produce particular spectra might be employed in the container. I have found that silicon and aluminum, when of proper purity, may both be made use of as negative electrodes in lighting apparatus such as is contemplated herein, and that no injurious exfoliation takes place whereby the efficiency of the apparatus is seriously affected. Accordingly, the present invention may be applied to vapor lighting apparatus having as its negative electrode either silicon or aluminum or such other solid material as does not harmfully exfoliate under the influence of the current, such negative electrode forming part of an apparatus containing a fixed or compound gas, or a mixture of gases, introduced into the apparatus during the process of manufacture and constituting the sole path for the current in the completed lamp.

I have shown my invention in the drawings which illustrate some of the means whereby the various functions referred to above are accomplished.

Figures 1, 2, 3 and 4, illustrate several forms of devices suitable for carrying out my invention.

Referring first to Fig. 2, I show means whereby a lighter gas, such as nitrogen, may be introduced into the container of a lamp having mercury or some other disintegrating and self reconstructing material as one of its electrodes. In this figure, 1 is a container of glass or other transparent material having an enlargement, 2, at its top, and having other enlargements, 3 and 4, at different points along its length. The positive elec-

trode in this instance is shown at 5, and the same may be constructed of iron or other suitable conducting material. The lead-wire, 6, supports or is connected with the said electrode within the bulb or enlargement 2. The negative electrode is located at 7, and may be assumed to be composed of mercury or molten tin. The negative electrode is connected to the external circuit by a lead-wire 8. The main portion of the luminous part of the apparatus is located between the enlargements 2 and 3. Between the enlargements 2 and 4, extends a comparatively small tube, 9, the purpose of which will be explained later on. This figure of the drawings shows the lamp in the process of manufacture, a tube 10 being joined to the bulb or enlargement 3, and serving as an inlet through which the nitrogen or other gas may be forced into the lamp. After a sufficient quantity of gas has been pumped in, the tube 10 may be sealed off at 11, and the lamp will then appear without the attached tube 10. It will be understood that the tube 10 is connected with a suitable pumping apparatus which will, however, be disconnected by the act of sealing off the tube. Assuming the lamp to be sealed off and completed and assuming that the proper current is applied to the terminals of the lamp through the lead-wires 6 and 8, the vapors generated by the passing current will mingle with the nitrogen or other lighter gas, the relative proportions of the vapors and gases being determined by the amount of vapor generated by the current and distributed through the container.

Owing to the construction of the container illustrated in Fig. 2, the mercury or other vapor generated passes into the light-giving portion of the container through the two enlargements 4 and 3. Between these enlargements a narrow throat, 12, is located which in itself chokes off the free passage of the vapor into the container, while the bulb 3, by reason of its cooling effect condenses a considerable portion of the mercury vapor which passes through the said bulb. The action of the bulb 4 is similar and will have served to cut down the amount of free mercury vapor in the light-giving portion of the container by condensing a portion of it and allowing it to return to the electrode 7. By properly proportioning the size of the bulbs 4 and 3 and of the throat 12, the amount of free mercury vapor in the light-giving portion of the container 1 can be cut down to any desired amount. In other words, the relative proportions of the mercury vapor and the nitrogen gas, or such other gases and vapors as may be selected, may be under control, bringing about stable conditions as to the relative proportions of the gases and vapors employed.

When such stable conditions exist, the lamp may be run upon a constant potential circuit and the spectrum of the combined gases will appear, thereby counterbalancing the insufficiencies of the mercury vapor spectrum alone.

I have observed in practice a tendency for the lighter gases to accumulate near the positive electrode or in other places out of the influence of the current. This may be counteracted to a great extent by means of the tube 9, connecting the region near the positive electrode with the part adjacent to the negative electrode. The excess of nitrogen or other comparatively light gas in the neighborhood of the positive electrode will find an outlet through the pipe 9 and will, according to the law of the distribution of gases and vapors, mingle with the vapors in the part of the lamp near the negative electrode and thus supply the deficiency of gas in that region.

In Fig. 1, I show a single large bulb 13 just above the negative electrode, the function of the bulb being that of condensing a large proportion of the vapors generated from the said electrode and preventing an excess of such vapors from entering the light-giving portion 1 of the lamp.

Between the receptacle containing the negative electrode and the condensing chamber above the said electrode, I may place a constricted passage or throat which will in the first instance choke off a portion of the vapor from entering the bulb or enlargement above the electrode as illustrated, for example, in Fig. 2. In other words, the constricted path for the vapor developed in the operation of the device may be arranged either beyond the first enlargement or between the receptacle for the negative electrode and the first enlargement or at any other effective point or points.

It will be understood that the enlargement 3 may be dispensed with or that any number of bulbs or enlargements may be utilized to secure the ends aimed at by the invention.

The employment of a considerable number of condensing chambers arranged along the luminous column is shown in Fig. 3, where bulbs 14, 15, 16 and 17 appear, their function being to control the amount of condensable vapor in the luminous portion of the container arising from the disintegration of the negative electrode. Should it be desired to increase the relative proportions of condensable vapor in the apparatus, this can be accomplished by artificial heating applied to the negative electrode or to the apparatus as a whole. On the other hand, the total light effect may be varied in the opposite sense by introducing into the lamp a relatively large proportion of nitrogen or other gas. By providing a condens-

ing chamber near the positive electrode, or at intermediate points, the operation of the apparatus as producing a spectrum containing large quantities of red, may be improved. Under some conditions it is found that the relative proportions of different colors may be controlled by the strength of the current applied to the apparatus. In some instances, I have used a compound gas in place of nitrogen or other fixed gas, such compound gas having a larger atomic or molecular weight than the nitrogen or other gas. Such a gas is represented by carbonic acid gas, for example, and this gas may give in conjunction with mercury vapor, a spectrum containing all the colors of sunlight in approximately the same proportions. This result is achieved with a considerably smaller expenditure of energy and complication of apparatus than is the case when nitrogen is used.

In Fig. 4 I show a simple form of apparatus in which the positive electrode 5 may be of iron, silicon, or other solid material and in which the negative electrode, 7 is of pure silicon or aluminum or other suitable solid material. In the container 1, I place during the process of manufacture a gas such as nitrogen, carbonic acid gas, or a mixture of gases, the single gas or mixture being adapted to develop under the influence of current passing through the apparatus the peculiar spectrum of their class. In this way the character of the light emitted by the lamp may be predetermined.

It will be understood that the tube 9 in Fig. 2 may be connected at one end to any point where the non-condensable gases or vapors are likely to accumulate and may be led thence to any other point in the apparatus where the condensable gases or vapors are likely to be present in excess.

In speaking of condensable and non-condensable gases or vapors in the present specification and claims, reference is had to comparative degrees of condensability, one gas being less easily condensed than the other. I find that gases having heavy molecular weight are generally more efficient as sources of light. I have found that a very effective means, under some conditions, for assisting the elimination of the excess of condensable vapor is the surrounding of a portion of the apparatus with water or other cooling material. Under some conditions, the cooling material, such as water, may be replaced by a forced draft of air or other cooling fluid.

In choosing the gases or vapors introduced into the apparatus, care should be taken to avoid such as will be made active in a chemical sense in the presence of any of the materials in the container.

In certain divisional applications filed respectively November 5th, 1904, Serial Num-

ber 231,482, and February 2nd, 1910, Serial Number 541,542, claims are made upon the apparatus described and shown in this application.

I claim as my invention:—

1. In a vapor electric lamp including an exhausted container and a vaporizable cathode, said container including a light giving portion distinct from the cathode chamber in which light is produced through the action of electric current on a suitable gas, the method of operation which consists in passing current through a gas having the desired spectrum, continuing said current into a vaporizable cathode thereby continuously producing vapor, opposing flow of said vapor and condensing escaping vapor before it reaches the light giving path.

2. The method of combining the rays of a gas or a mixture of gases whose spectrum contains red with the rays of mercury vapor in a lamp, and preventing the domination of the characteristic rays of mercury in the resulting spectrum, which consists in introducing into the lamp a definite quantity of a gas, and limiting the free passage of mercury vapor to the light-giving column.

3. The method of securing a proper operating mixture of gases having different spectra for the purpose of producing a predetermined luminous effect under the influence of electric current, one of the said gases being condensable and the other non-condensable, which consists in providing a definite quantity of the non-condensable gas in a container and controlling the amount of condensable gas by mechanically or physically limiting the supply of said gas within any given portion of the container.

4. The method of securing a proper operating mixture of gases having different spectra for the purposes of producing a predetermined luminous effect under the influence of electric current, one of the said gases being condensable and the other non-condensable, which consists in controlling the supply of condensable gas by regulating the temperature of the apparatus.

5. The method of securing a proper operating mixture of gases having different spectra for the purposes of producing a predetermined luminous effect under the influence of electric current, one of the said gases being condensable and the other non-condensable, which consists in regulating the supply of condensable gas by controlling the temperature of the apparatus and limiting the free passage of said condensable gas through the container.

6. The method of securing a proper operating mixture of gases having different spectra for the purposes of producing a predetermined luminous effect under the influence of electric current, one of the said

gases being condensable and the other non-condensable, which consists in supplying a definite quantity of non-condensable gas to the apparatus, supplying condensable gas thereto and controlling the supply of said condensable gas by regulating the temperature of the apparatus and limiting the free passage of said condensable gas through the apparatus.

7. The method of securing a proper mingling of a non-condensable gas capable of developing additional rays with mercury vapor in a vapor lamp, which consists in supplying a definite quantity of the non-condensable gas to the lamp, developing the mercury vapor from a mercury electrode in the lamp and limiting the free passage of the mercury vapor through the light-giving column.

8. The method of securing a proper mingling of a noncondensable gas capable of developing additional rays with mercury vapor in a vapor lamp, which consists in supplying a definite quantity of the noncondensable gas to the lamp, developing the mercury vapor from a mercury electrode in the lamp and controlling the amount of mercury vapor developed in the lamp by regulating the temperature of the lamp.

9. The method of securing a proper operating mixture of gases having different spectra for the purposes of securing a predetermined luminous effect under the influence of electric current, which consists in introducing a plurality of gases differing in molecular weight, passing current through said gases for the purpose of obtaining light therefrom and resisting the tendency of the gas of lighter molecular weight to be reduced below the normal amount in the path traversed by the current by providing an excess of said gas in the non-operating condition.

10. The method of securing a proper operating mixture of gases having different spectra for the purposes of producing a predetermined luminous effect under the influence of electric current, which consists in exposing to the passage of current between the electrodes a mixture of a plurality of gases having different molecular weights and opposing the natural relatively greater tendency of the gas of heavier molecular weight to remain in the current path by reducing the relative quantity of said heavy gas in the non-operating condition below that required for the proper light spectrum in the current path during operation.

11. In an electric lamp comprising an exhausted container and electrodes therefor, the method of operation which consists in passing current through a permanent gas in a light giving path thereby generating a condensable vapor at a point outside said light giving path, preventing an excess of

said condensable vapor in the light giving path by successively and repeatedly applying the process of condensing and throttling to the condensable vapor between the point of generation and the light giving path.

12. The method of predetermining the spectrum to be given by a vacuum electric apparatus, which consists in inclosing within the vacuum chamber definite quantities of permanent gases in proportions adapted to give the desired spectrum and supplying in a non-operating condition an excess of a gas having a relatively high dispersive tendency under the influence of electric current, said excess being sufficient to maintain in the light giving path the normal proportion of said gas in the operating condition.

13. The method of getting a definite quality of light from an electric apparatus containing a gas or mixture of gases giving the desired spectrum, which consists in producing light by the passage of current through the apparatus, through the action of said current producing a condensable gas, said gas not being required as a light giving medium and reducing the quantity of said unnecessary gas in the vapor column to a negligible quantity.

14. The method of preventing the domination of a spectrum of a given electric lamp by a production in excess of a condensable vapor from a vaporizable electrode through the action of the current, which consists in passing current through the apparatus, causing said current to produce light within the apparatus through the action of a suitable gas and operating a portion of the apparatus in contact with the condensable gas at a temperature at which the vapor tension of said condensable gas is adapted to the normal production of light.

15. In a gas electric lamp containing a mixture of gases in which there is a tendency for too large a quantity of one gas to collect in a portion of the light-giving column, said gas being condensable the method of getting the proper spectrum, which consists in operating the light-giving portion of the electric lamp at a temperature low enough to reduce the partial pressure of any condensable gas which tends to excess below the harmful point.

16. In an electric lamp in which a mixture of a condensable and noncondensable gas is utilized for a production of light of a definite spectrum, the method of operation which consists in passing current through the lamp thereby accumulating an excess of a noncondensable gas in one location out of the light giving path, returning said accumulated gas into the light giving path and generating a condensing vapor from a negative electrode within the lamp.

17. The method of operating an electric

lamp in which current excites light from a suitable mixture of one or more noncondensable gases with a condensable gas, which consists in passing current through the light giving portion of the lamp, causing said current to produce a circulation of a noncondensable gas through a closed path including said light giving portion and generating and condensing a condensable gas from an electrode within said lamp.

18. In a vapor electric lamp, the method of securing high efficiency and light of a proper spectrum, which consists in securing a mixture of mercury vapor and a gas adapted to supplement the mercury spectrum and having a relatively large molecular weight and passing current through these gases in a suitable container.

19. The method of securing a proper mixture of gases having definite spectra in an electric lamp, which consists in providing the proper proportions of said gases in the current path to give the desired spectrum, and providing out of the current path an excess of each gas corresponding in quantity to its molecular weight to maintain the said desired proportion.

20. In an electric lamp relying for its spectrum on the character of the gas or gases in the light giving portion, the method of operation which consists in passing current through the light giving portion, thereby producing light and generating by said current from a cathode in said lamp a disintegrated nonvaporizable material.

21. The method of securing a proper commingling of mercury vapor and a gas adapted to develop red rays under the influence of an electric current, which consists in combining with a mercury vapor, a gas adapted to develop red rays and having a relatively high molecular weight, and preventing the domination of the spectrum of this material in view of its heavy molecular weight by limiting the relative quantity of said material in correspondence with said molecular weight.

22. In a vapor electric lamp comprising a container, electrodes therein and a gas therein adapted to develop a suitable spectrum under the influence of electric current traversing the same, the method of operation which consists in including a suitable gas in the light giving portion of an exhausted container passing current therethrough, maintaining a vapor in another portion of said container passing the current therethrough and preventing diffusion between the gas and the vapor.

23. In an electric lamp in which light of a definite spectrum is produced by the action of current on a suitable mixture of gas, the method of operation which consists in passing current through the light giving portion of the lamp, thereby accumulating

a noncondensable gas at one end, returning said gas out of the current path at the other end of said light giving portion and generating and condensing vapor from an electrode with said lamp.

24. The method of manufacturing vapor electric lamps adapted to produce a desired spectrum by the combination of one or more permanent gases with a condensable gas, which consists in connecting the apparatus to an exhaust pump, removing the air therefrom, introducing into the apparatus a definite limited quantity of permanent gas, adapted to produce the desired spectrum under operating conditions and sealing off the apparatus from the pump and from the supply when this quantity of gas has been introduced.

25. The method of controlling the quantity of the condensable vapor in an electric lamp operating through the properties of a mixture of condensable and permanent gases, which consists in introducing quantities of the gases at least sufficient to produce the normal operating quantities of each, the condensable gas only being in excess and eliminating the excess of said condensable

gas by externally cooling to produce a condensation of a portion of said condensable gas.

26. The method of producing a predetermined luminous effect by means of a gas or vapor electric apparatus containing as one of its electrodes a conducting liquid capable of being volatilized and condensed under the influence of electric current and also containing a gas or vapor other than the one which is developed from the conducting liquid under current influence, which consists in starting the apparatus by any approved means and condensing all or a portion of the vapors developed from the described electrode at or near the point of development, thereby permitting current to pass mainly through the said other gas or vapor and developing its characteristic light.

Signed at New York, in the county of New York and State of New York, this 8th day of February A. D. 1904.

PERCY H. THOMAS.

Witnesses:

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GEORGE H. STOCKBRIDGE.