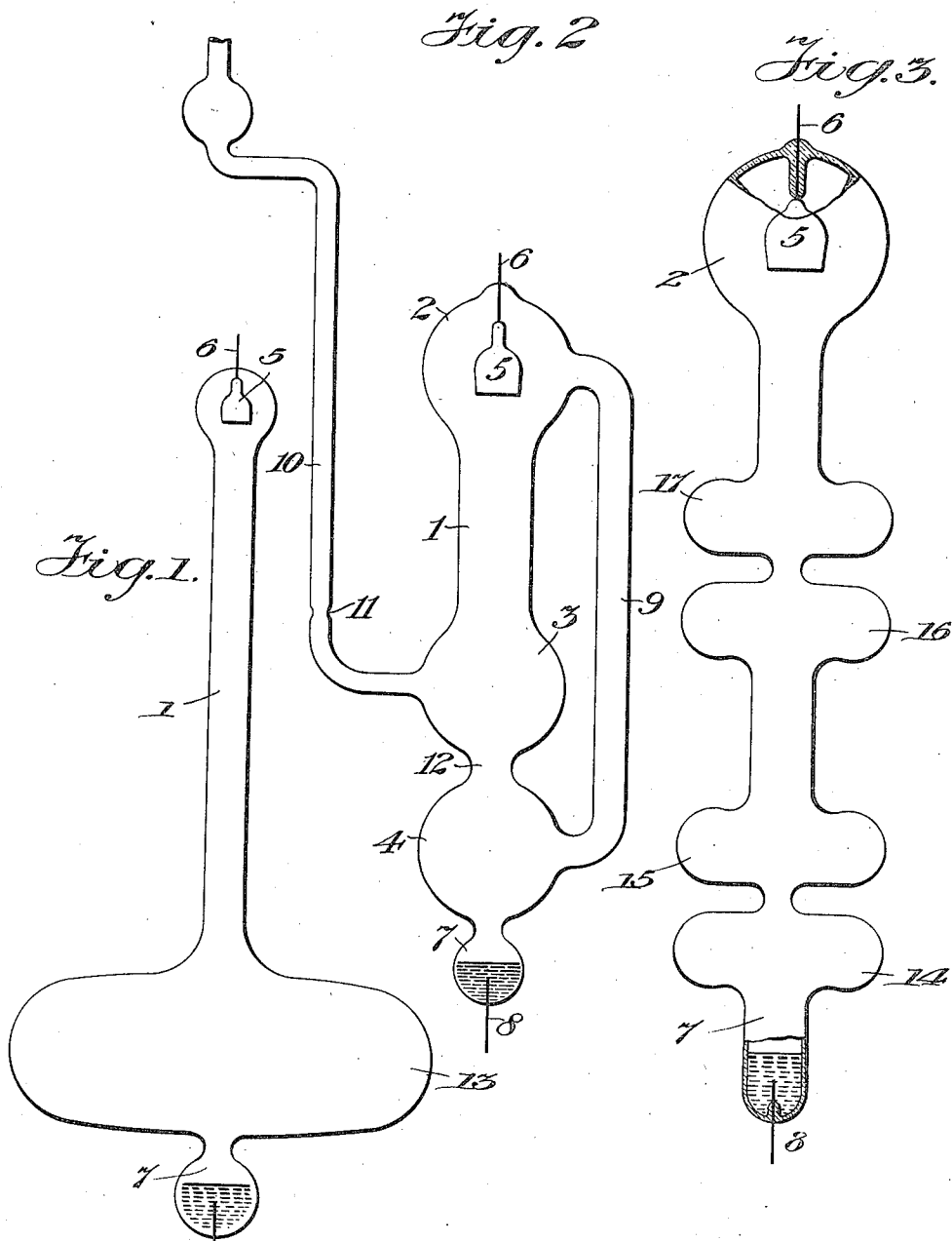


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VAPOR ELECTRIC LAMP.
APPLICATION FILED NOV. 5, 1904.

1,008,998.

Patented Nov. 14, 1911.



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VAPOR ELECTRIC LAMP.

1,008,998.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, PERCY H. THOMAS, a citizen of the United States, and resident of Montclair, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Vapor Electric Lamps, 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 partitions, 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, and 3, 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 electrode 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 distintegration 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 condensing 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.

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.

This application is a division of my application filed February 9th, 1904, Serial Number 192,779, and a companion to my application Serial Number 541,542, filed February 2nd, 1910, which is also a division of the above first named application.

I claim as my invention:—

1. The combination with a transparent container inclosing suitable electrodes, one of which is of a material capable of developing a condensable gas or vapor, of a fixed or non-condensable gas within the container, and means for controlling the supply of condensable gas or vapor therein.

2. The combination with a transparent container inclosing suitable electrodes, one of which is of a material capable of developing a condensable gas or vapor, of a definite supply of fixed or non-condensable gas

within the container, and means for controlling the relative proportions of the non-condensable and the condensable gases or vapors.

5 3. The combination with a transparent container inclosing suitable electrodes, one of which is of a material capable of developing a condensable gas or vapor, of a definite supply of fixed or non-condensable gas
10 within the container, and means for controlling the relative proportions of the non-condensable and the condensable gases or vapors, such means consisting of one or more temperature regulators.

15 4. The combination with a transparent container inclosing suitable electrodes, one of which is of a material capable of developing a condensable gas or vapor, of a definite supply of fixed or non-condensable gas
20 within the container, and means for controlling the relative proportions of the non-condensable and the condensable gases or vapors, such means consisting of mechanical obstructing devices limiting the free passage
25 of condensable vapor into the light giving column in the container.

5. The combination with a transparent container inclosing suitable electrodes and a definite quantity of non-condensable gas
30 or vapor, of a condensable gas or vapor in the container, and means for causing a circulation of the non-condensable gas or vapor through the condensable gas or vapor.

6. The combination with a container inclosing suitable electrodes, the negative electrode being of a material adapted to develop a condensable vapor, of a quantity of non-condensable gas or vapor in the container definite in amount relative to the
40 quantity of condensable vapor, whereby the spectrum of the combination is controlled, of a return circuit extending from the region near the positive electrode to the region near the negative electrode.

45 7. The combination with a container inclosing suitable electrodes, the negative electrode being of a material adapted to develop a condensable vapor, of a definite quantity of non-condensable gas or vapor, the said
50 gas or vapor having an atomic or molecular weight other than that of the condensable vapor.

8. The combination with a container inclosing suitable electrodes, the negative electrode being of a material adapted to develop a condensable vapor, of a definite quantity of non-condensable gas or vapor, the said
55 gas or vapor having an atomic or molecular weight properly proportioned to that of the condensable vapor whereby the relative amounts of light from the vapors are predetermined.

9. The combination with a transparent

container inclosing suitable electrodes, the negative electrode being of mercury, of a
65 definite quantity of gas or vapor, the spectrum of which contains red rays, and means for controlling the relative proportions of the said gas and the vapor of mercury.

10. The combination with a transparent
70 container inclosing suitable electrodes, the negative electrode being of mercury, of a definite quantity of gas or vapor, the spectrum of which contains red rays, and means for controlling the relative proportions of
75 the said gas and the vapor of mercury, such means consisting of one or more heat regulating devices.

11. The combination with a transparent container inclosing suitable electrodes, the
80 negative electrode being of mercury, of a definite quantity of gas or vapor, the spectrum of which contains red rays, and means for controlling the relative proportions of the said gas and the vapor of mercury, such means
85 consisting of constricting devices limiting the passage of mercury vapor into the light giving column.

12. In a vapor electric lamp, the combination with a gas giving a spectrum having
90 color bands not uniformly distributed, of a natural excess of another gas or vapor giving complementary color bands, and means for removing the excess from the light giving
95 portion of the lamp.

13. A volatile negative electrode, and means for condensing approximately all the vapors of the negative electrode at or near the same, in combination with a gas or vapor differing from the vapor developed from
100 the negative electrode, the said other gas or vapor acting as a conducting medium through a portion of the vapor apparatus.

14. In a gas or vapor electric apparatus comprising a container, electrodes therein,
105 at least one of which is of a material which is capable of being volatilized and again condensed, a gas or vapor other than that developed from the said electrode, and means for condensing approximately all the
110 vapors developed from said electrode at or near the electrode itself.

15. In a gas or vapor electric apparatus comprising a container, electrodes therein,
115 at least one of which is of mercury, a gas or vapor other than mercury-vapor, and means for condensing approximately all the vapor of mercury developed from said electrode at or near the electrode itself.

Signed at New York, in the county of New
York, and State of New York, this 3rd day
of November A. D. 1904.

PERCY H. THOMAS.

Witnesses:

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