P. C. HEWITT.

INDUCTION LAMP.

APPLICATION FILED JULY 20, 1904.

966,204. **Patented Aug. 2, 1910.**

3 SHEETS—SHEET 1.

Fig. 1

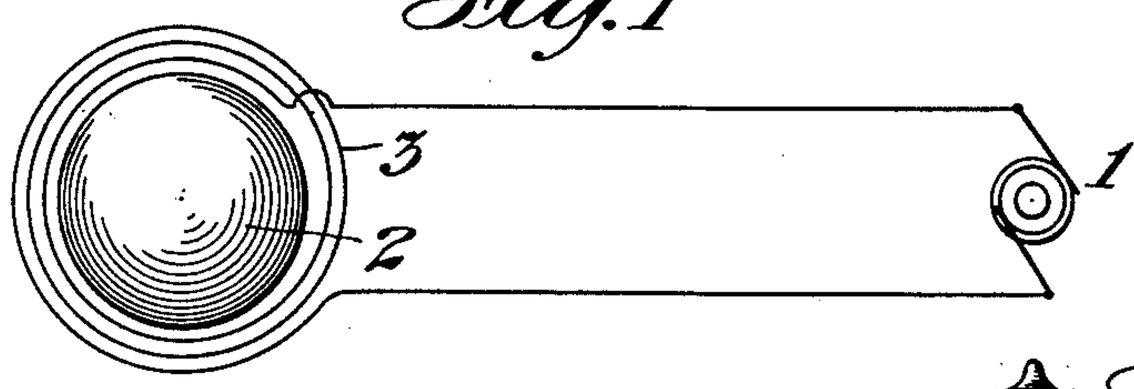


Fig. 2

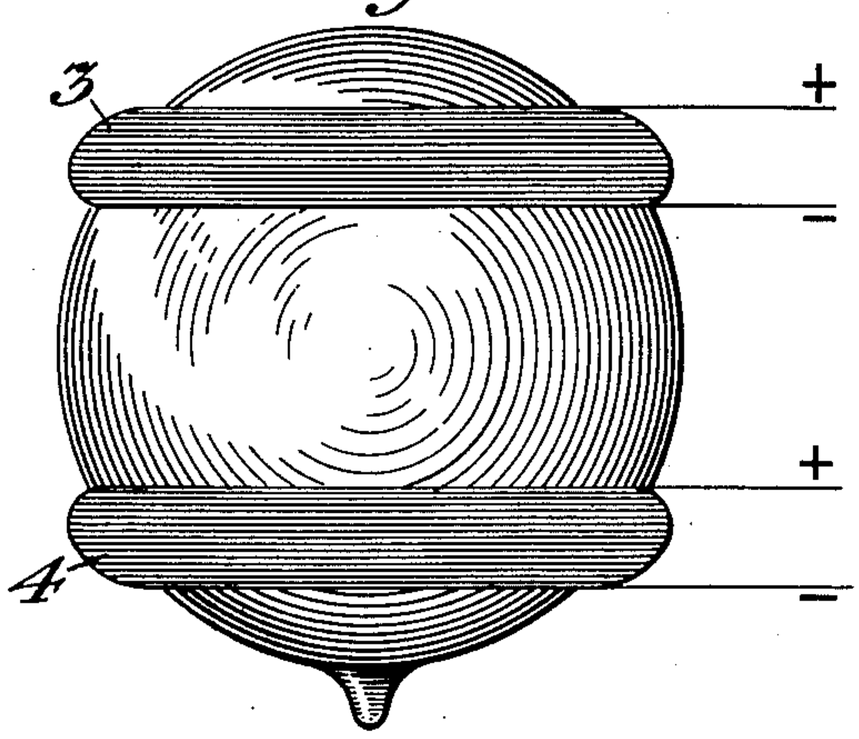


Fig. 3

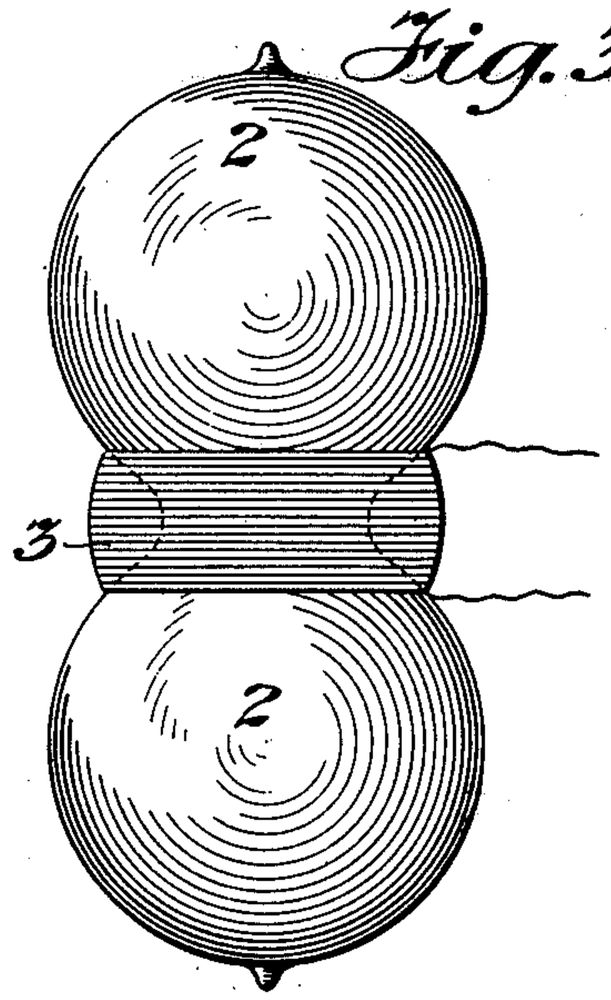


Fig. 4

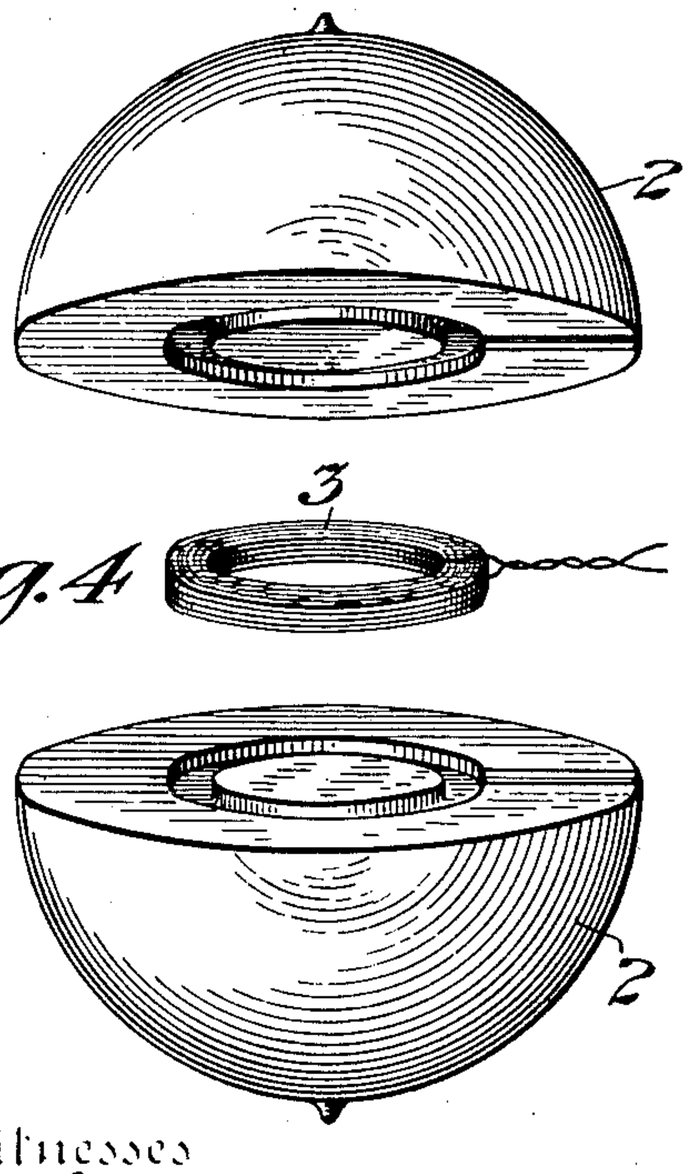
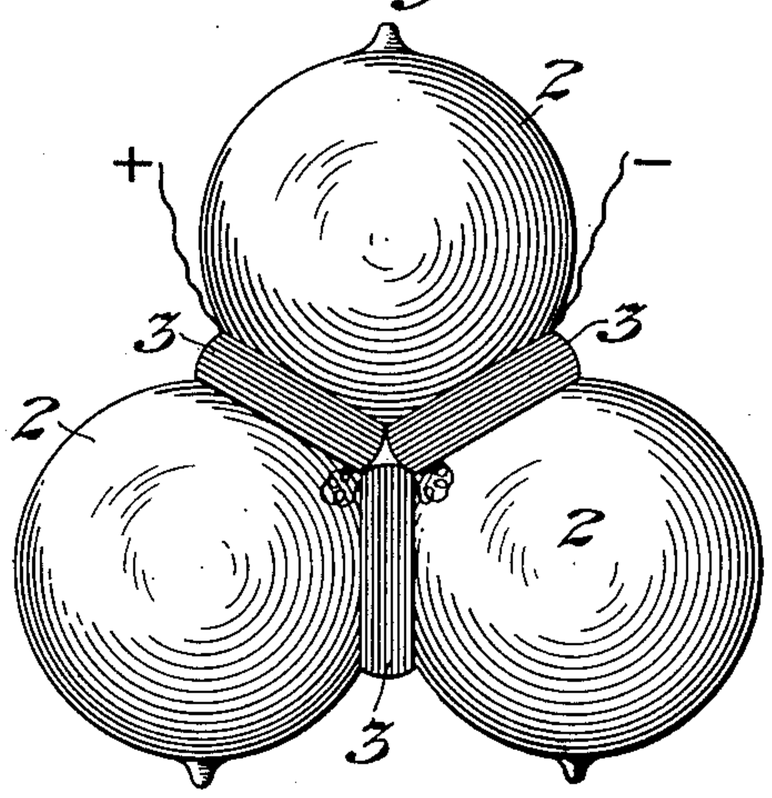


Fig. 5



Witnesses
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3 SHEETS—SHEET 2.

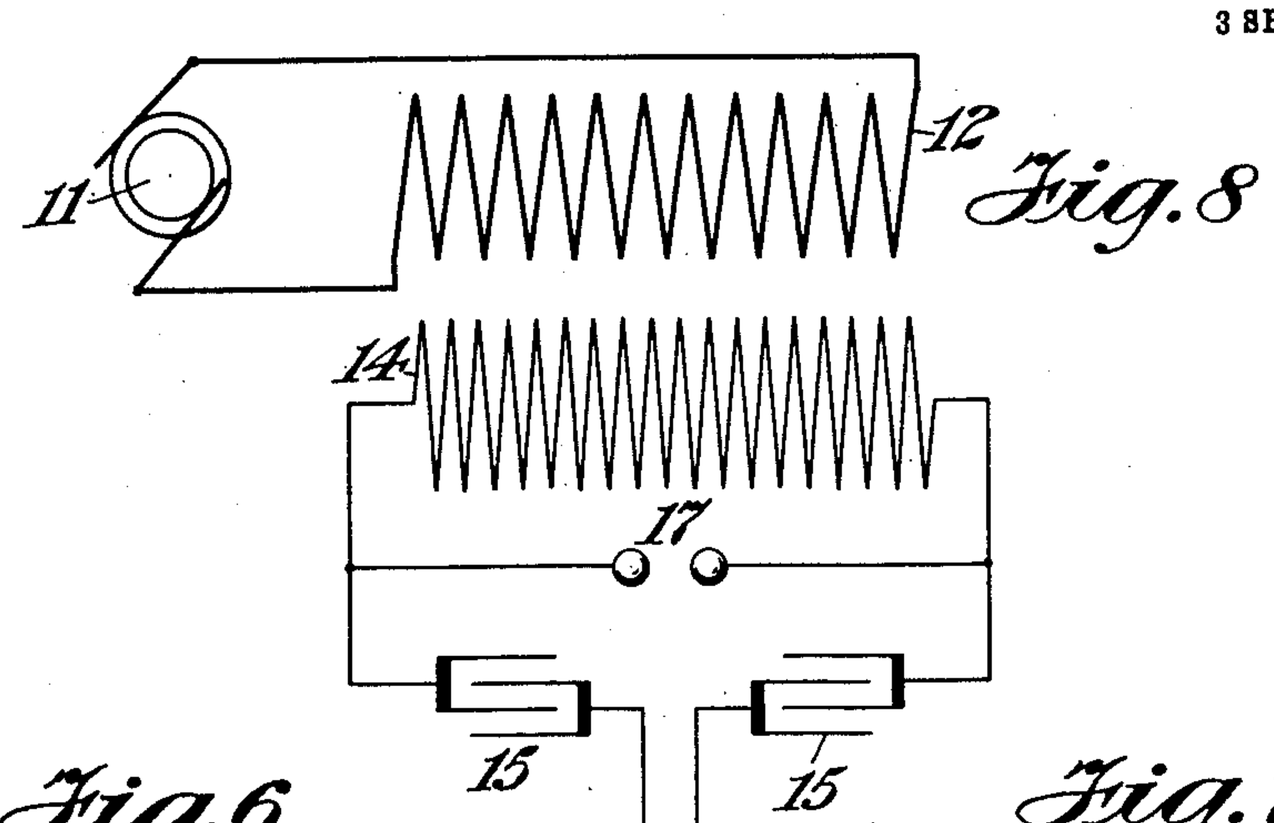

Fig. 8

Fig. 6

Fig. 7

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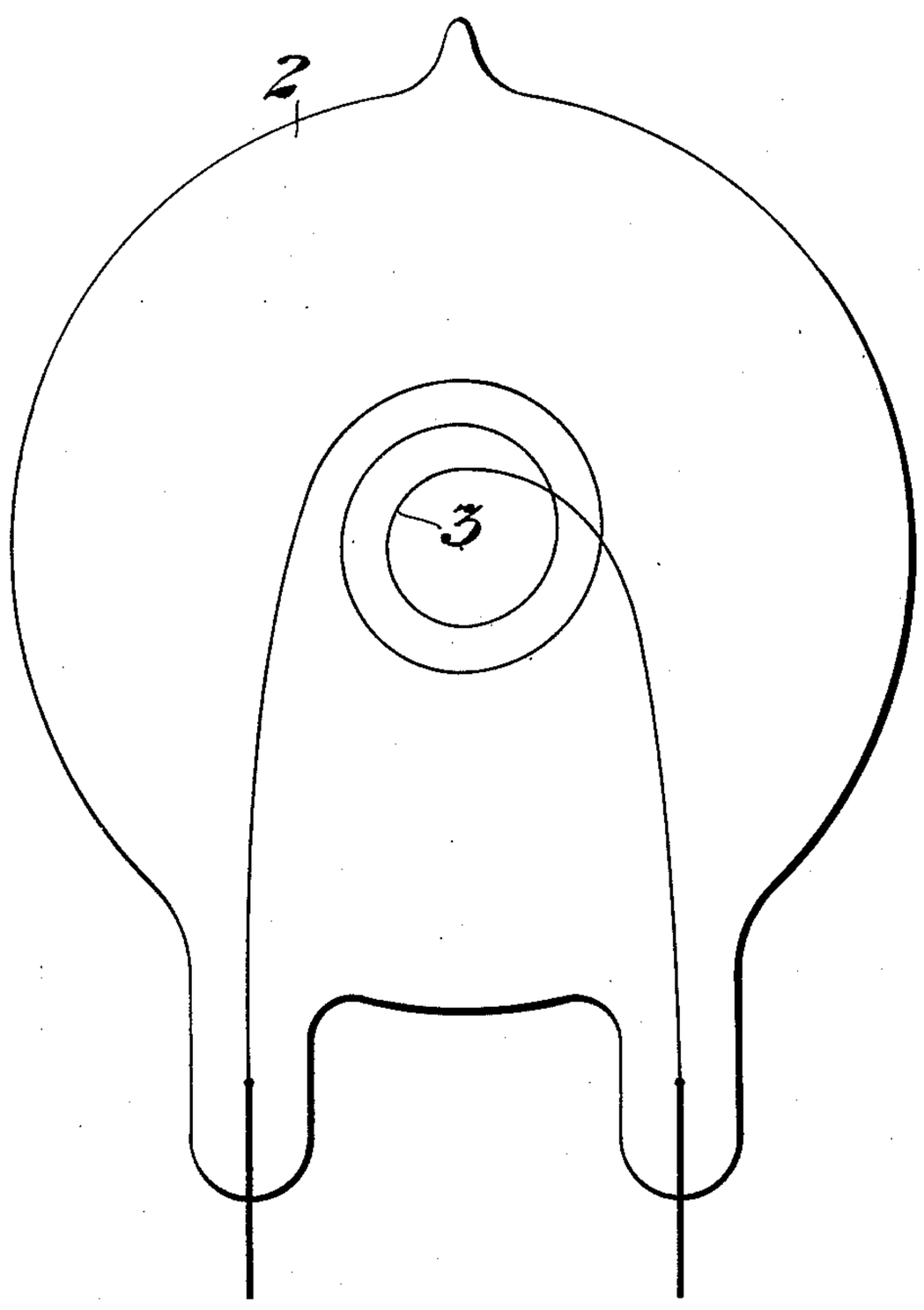
3 SHEETS—SHEET 3.

Fig. 9



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UNITED STATES PATENT OFFICE.

PETER COOPER HEWITT, OF NEW YORK, N. Y., ASSIGNOR TO COOPER HEWITT ELECTRIC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

INDUCTION-LAMP.

966,204. Specification of Letters Patent. **Patented Aug. 2, 1910.**

Application filed July 20, 1904. Serial No. 217,305.

To all whom it may concern:

Be it known that I, PETER COOPER HEWITT, a citizen of the United States, and resident of New York, county of New York, State of New York, have invented certain new and useful Improvements in Induction-Lamps, of which the following is a specification.

I have found that under certain conditions, it is possible to render a suitable inclosed gas or vapor highly luminous and light-radiant by means of electric currents induced therein through the instrumentality of an exciting coil traversed by alternating or intermittent electric currents. The character and density of the gas or vapor must be such that under the influence of the current traversing the exciting coil, it will become an electric conductor and act somewhat in the manner of the secondary conductor of a transformer of which the exciting coil is the primary.

An inclosed gas or vapor appears to be capable of becoming more or less luminous by two distinct kinds of electrical effects. In the well known Geissler tube, a gas or vapor is rendered slightly luminous but the gaseous medium appears striated and does not act as a true electrical conductor.

In certain patents issued to me September 17, 1901, I have described a form of gas or vapor device in which an inclosed gas or vapor becomes a true electric conductor. My present invention secures a similar result by rendering the vapor a true electric conductor under the influence of the electro-motive-forces induced therein by the action of the currents traversing the primary and when traversed by the currents due to these electro-motive-forces it preserves its conductive characteristics, and at the same time yields an intense and efficient light. To accomplish this it is necessary not only that the proper gas or vapor be selected and maintained at the proper density but that a primary or exciting coil of the proper character traversed by electric currents having the necessary voltage and characteristics with reference to variation and frequency be supplied so as to render the vapor capable of carrying the amount of current required for it to obtain its maximum light radiancy.

In practice I have obtained excellent results by employing an inclosed chamber of glass, spherical in form, containing a small quantity of mercury, all foreign gases and impurities having been extracted before the inclosing chamber is hermetically closed. The primary coil is then placed in inductive relation thereto, and means are provided for causing it to be traversed by electric currents of exceedingly high frequency and having sharply defined periods. The best means known to me of securing this result will be described in connection with the accompanying drawing wherein—

Figure 1 is a diagrammatic view of one form of my lamp connected with a generator; Fig. 2 is an elevation of one form of my lamp using two primary coils; Figs. 3, 4, 5, 6 and 7, illustrate other forms of lamps; Fig. 8 is a diagrammatic view of several lamps and a form of generator in circuit therewith and Fig. 9 illustrates a modification.

In the drawings, 1 is any suitable source of rapidly varying currents, and 2 is a closed container of any preferred shape. Within the vessel 2 is a gas or vapor of suitable density to be rendered radiant or light-emitting. I may conveniently use mercury vapor as the light-emitting medium.

A coil 3, of insulated wire of the proper number of turns constitutes the primary coil of the transformer, the vapor or gas within the vessel being the secondary circuit. The coil 3 is connected with the source 1.

On the passage of a current of the proper character through the coil 3, a current is induced in the vapor, and the vessel becomes brightly luminous. A change in position of the primary coil causes a corresponding change in the position of the luminous center. If, however, the amount of energy imparted from the source 1 be sufficient, practically all of the vapor in the lamp may be made to act as secondary and to give the lamp a very intense brightness. The addition of a second coil, 4, on the globe of the vessel 2 causes an increase of luminosity (see Fig. 2).

In Fig. 3, a form of lamp is shown in which one bulb, 2, is made with a narrow neck and a coil 3 encircles the narrow portion. The operation is essentially the same as that described in reference to Fig. 1.

In Fig. 4, a form of lamp is shown consisting of two hemispherical bulbs, 2, 2, having suitable depressions in their faces for receiving the coil 3. The bulbs are

placed together with the coil 3 between them and currents through the coil act upon the contents of both bulbs.

In Fig. 5 a modification is shown in which three bulbs 2, 2, 2, are shown arranged in close proximity to each other with coils 3, 3, 3, placed between them. These three coils may be connected in series or in parallel as desired.

In Figs. 6 and 7 the gas or vapor is inclosed in annular spaces, and in the former figure the coil 3 is arranged out-side the annulus, and in the latter figure inside the annulus, as shown.

In Fig. 8 I have represented diagrammatically one form of apparatus giving a rapidly varying current suitable for use in operating my lamp. The generator is indicated at 11, and produces an alternating current of 125 to 300 periods and of a voltage of 50 to 100 volts, these figures being given by way of example. The generator supplies the primary coils, 12, of a transformer, the secondary coil 14, of which delivers an induced current of, say, 6000 volts. This induced current is delivered to one or more condensers of suitable capacity, which may be arranged to be discharged through the line 16. I usually prefer to use two condensers, 15, 15, as shown, using the current induced between them through the line 16. At 17 I arrange a spark gap which, in the present instance, is a well known form of vapor circuit breaker or interrupter, of the type fully shown and described in my prior applications filed April 25th, 1902, and February 9th, 1903, which are now respectively Letters Patent Nos. 780,999 and 780,997. The said spark gap or said discharge device is in shunt across the line 16 between the secondary 14 and the condensers 15—15. The spark gap limits the charge of the condensers and serves to discharge them and thereby regulates the frequency of the current in the line 16.

By using a discharge gap of the character herein indicated I am able to secure a higher frequency than is possible with the ordinary air gap, this being due to the well-known qualities of a vapor device of this sort whereby it opposes to the initial passage of the current through it a definite sharply defined resistance, after which the gas or vapor conducts current down to a definite low limit of electro-motive-force, the limit at which it ceases to conduct being also clearly and sharply defined. The medium through which the discharge passes being confined and therefore constantly exposed to the same conditions and means being provided either in the construction of the container or by other devices to maintain constant temperature in the apparatus, there is no variation in the action of the device and it may be depended upon to give currents of uniform rate. This rate will depend upon the particular construction of the apparatus as related to the current supplied to the system. Accordingly, within limits, the circuit 16, for example, can be supplied with currents of any desired frequency, such as would be suited to the density of the vapor in the lamps 2—2.

It may be stated that the action of the vapor circuit breaker 17 absorbs so small a fraction of the total energy flowing therein, that the loss is practically negligible, and for this reason the device is well suited for the purpose of the invention herein described. It may be also stated that the discharge device herein described does not vary the natural rate of oscillation of the circuit and does not sensibly reduce the number of such oscillations.

Every time the condensers are charged and discharged the current induced between them will flow back and forth through the line 16. The current flowing through this line is a rapidly alternating current of considerable quantity.

One of the glass vessels, 2, being placed in the field of the coil 3, will act as a single turn secondary, tapping off the amount of current that the lamp is constructed to take. The coil 3 thus becomes the primary and the vapor in the vessel the secondary of my vapor transformer or lamp. With a pressure of 6,000 volts and a bulb six inches in diameter, a coil of fifteen turns will serve to illuminate the bulb.

In respect to the winding of the coils for a particular current, I have found that the best results are generally attained by actual experiment, inasmuch as the mutual induction is greatly affected by the thickness of the insulation and the consequent proximity or separation of one wire with relation to another. Theoretically, one turn should give the best results, but in practice this is not the case; and it is found that on adding turn after turn, always having the same source of current some particular number of turns will cause a faint luminosity while on increasing the number of turns, a point is reached where true conduction takes place, when the apparatus is properly adapted to the current. On still further increasing the number of turns, the maximum luminosity is reached, beyond which point a further increase in the number of turns puts the lamp out of operation. This is apparently because the device is a step down transformer with an unchangeable single turn secondary and if there are too many turns in the primary, the ratio of the step down transformer will be too great and the voltage in the secondary will be too low. The coil should not have inductance enough to dampen out the action of the condenser.

As to the main line, it may be stated that

for a line of considerable length, the outgoing and return wires should be near each other and parallel or concentric, unless other precautions are taken to suit the line to the currents carried.

In manufacturing my lamp I usually proceed as follows: The lamp is connected with an exhaust pump to remove the water and any vapors that may be contained in the glass of the bulb, the bulb being heated during the process of exhausting. I then introduce into or generate in the lamp the vapor upon which I desire to operate and which is to act as the secondary, still retaining the connection with the exhaust pump, usually introducing more of the vapor than it is intended shall remain in the lamp when completed. While still connected with the exhaust pump, I place a coil, such as the primary 3 of Fig. 2 in such a position that its field may include the bulb and its inclosed vapor. There is then passed through the primary coil a rapidly varying current, and the effect upon the vapors in the bulb is carefully noted. After the foreign and objectionable gases have been pumped out, and the gas or vapor which is to be illuminated has reached the proper density, the bulb receives the desired amount of current and becomes brilliant. Then after a steady state or stable condition has been reached it is then sealed off from the pump and is finished. This steady state can be attained if the size and shape of the lamp is such that it will radiate heat as fast as developed when in the desired state.

The source 11 and the secondary source 12 and 14 constituting the transformer are of a character which adapts them to generate currents of any desired quantity or electromotive-force, wherein they differ from the electric sources hitherto proposed in connection with experiments in lighting through the effects of induction on inclosed gases or vapors or on vacuum tubes. In other words, the source of the current in my lamp is dynamic, as distinguished from a source of static electricity, and this difference, among other things, makes my lamp a practical operative device and not a mere experimental laboratory apparatus. The term "dynamic electricity" and similar expressions as employed here and in the claims denotes electricity in current form, representing a flow rather than a static discharge whether the current is derived from a dynamo electric generator or some other suitable source.

In Fig. 9, a modification is illustrated in which the primary or exciting coil 3 is placed within the chamber 2, the leading-in wires passing through its walls.

The characteristic of a vapor acting as a conductor is that its resistance tends to vary inversely with the current carried, other things being the same. In the case where the current is induced in the vapor by transformer action, the vapor acting as a secondary, it is characteristic that where there is sufficient inductive transfer thereto to cause current flow, it will then have a greater ability to absorb current than a conductor of the first class wherein resistance is substantially constant and when acted upon by the oscillatory system it will absorb substantially all the energy of a whole transformer in the first oscillation, thereby giving the luminosity due to all the energy of a whole train of oscillations concentrated in the short interval of time of one oscillation. This obviously results in saving the frictional and other losses involved in prolonged fluctuations of energy through the circuit.

I do not claim herein the broad method and apparatus claimed in my Patents Nos. 843,533 and 843,534.

What I do claim herein is—

1. The method of producing light in a rarefied gas or vapor within a chamber, which method consists in exciting the gas to luminosity by passing rapidly varying currents through a primary within a body thereof, said currents being of such quantity and such rate of variation as to electromagnetically induce in said vapor currents whose electromotive force is above a critical minimum, said minimum being the lowest voltage at which the gas is enabled to become a true conductor of electricity.

2. The method of producing light in a rarefied gas or vapor within a chamber, which method consists in exciting the gas to luminosity by passing rapidly varying currents through a primary in contact with a body thereof, said currents being of such quantity and such rate of variation as to electromagnetically induce in said vapor, currents whose electromotive force is above a critical minimum, said minimum being the lowest voltage at which the gas is enabled to become a true vapor conductor of electricity.

3. The method of breaking down a dielectric consisting of a body of vapor, which method consists in locating within the vapor a primary circuit, and causing said primary circuit to generate within the vapor a rapidly varying magnetic field, having its rate of variation and its total energy so predetermined with reference to the reluctance and current carrying capacity of said vapor as to break down the dielectric quality of said vapor and to cause it to act as a low resistance vapor conductor, substantially as described.

4. The method of preventing oscillations in an excited oscillatory circuit, which method consists in causing said oscillatory circuit to generate a magnetic field having such rapidity of variation and such total

energy, located within a vapor of such volume, density, and conductivity, that said vapor, acting as a single turn secondary, will absorb substantially all of the energy of said oscillatory circuit within the time of the natural period of a single oscillation thereof, substantially as described.

Signed at New York, in the county of New York, and State of New York, this first day of July, A. D. 1904.

PETER COOPER HEWITT.

Witnesses:

G. C. DEAN,

V. BIGELOW.