No. 843,533. PATENTED FEB. 5, 1907.

P. C. HEWITT.

INDUCTION VAPOR OR GAS ELECTRIC LAMP.

APPLICATION FILED APR. 18, 1900.

2 SHEETS—SHEET 1.

Fig. 1

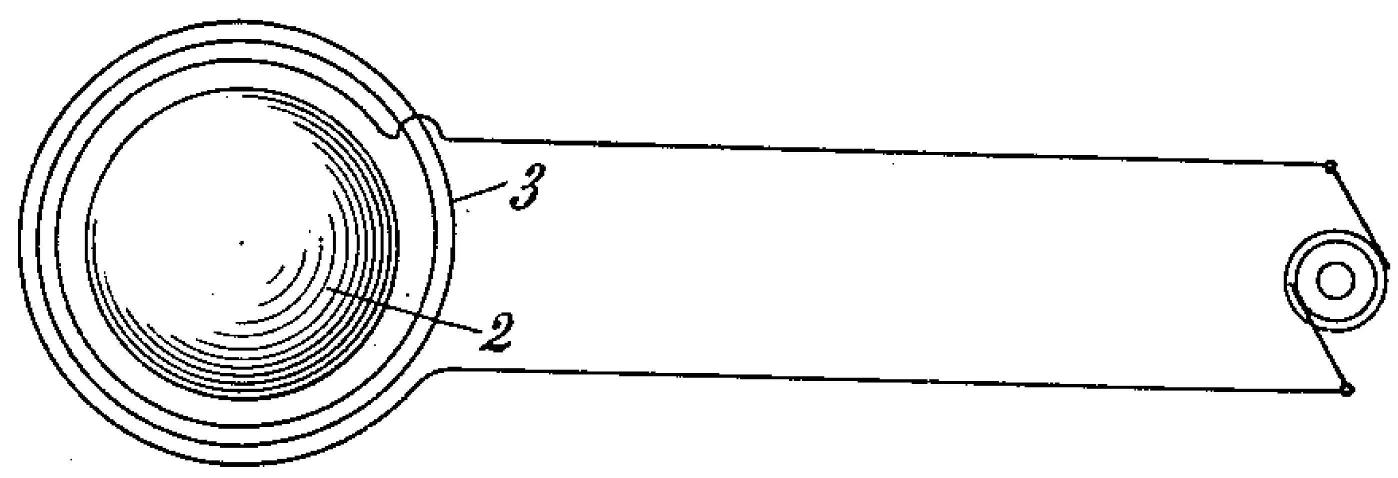


Fig. 2

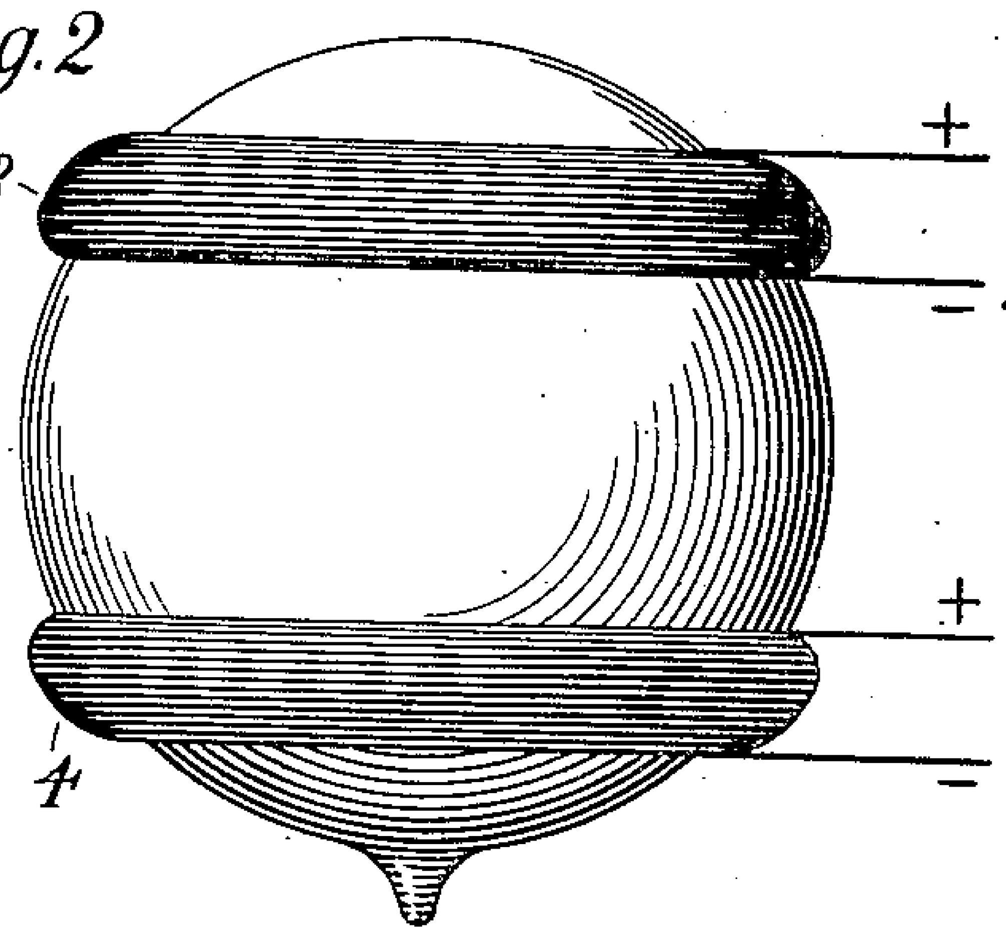


Fig. 3

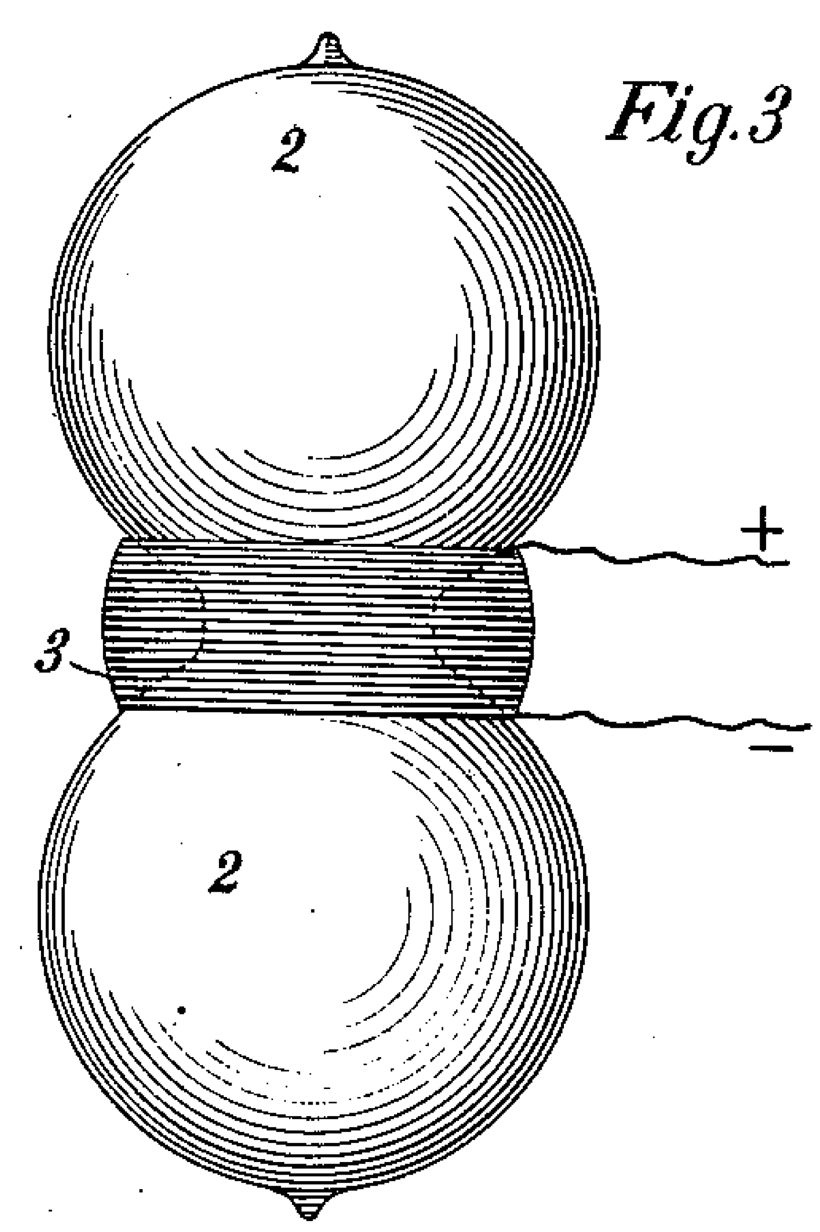


Fig. 4

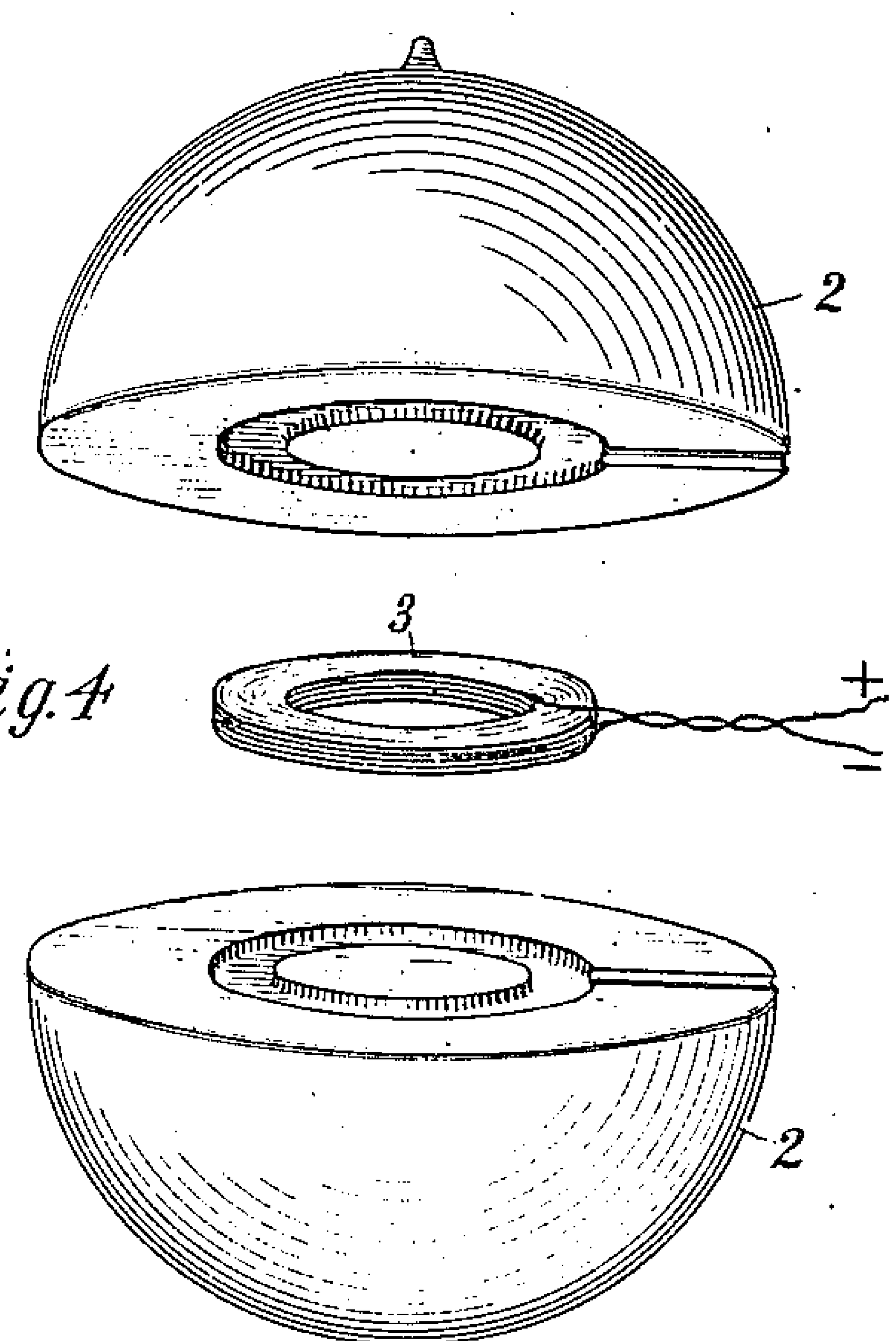
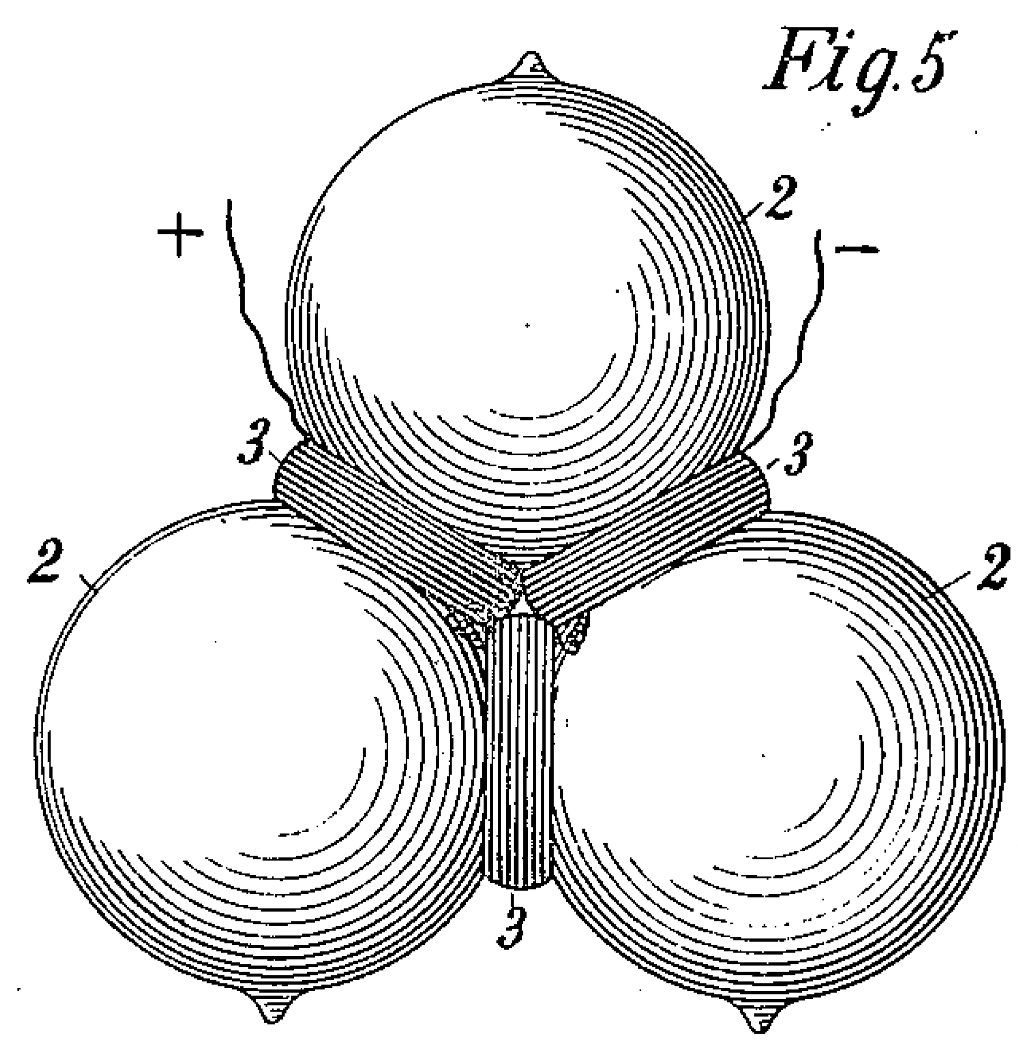


Fig. 5



Witnesses:
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by Charles A. Terry Att'y

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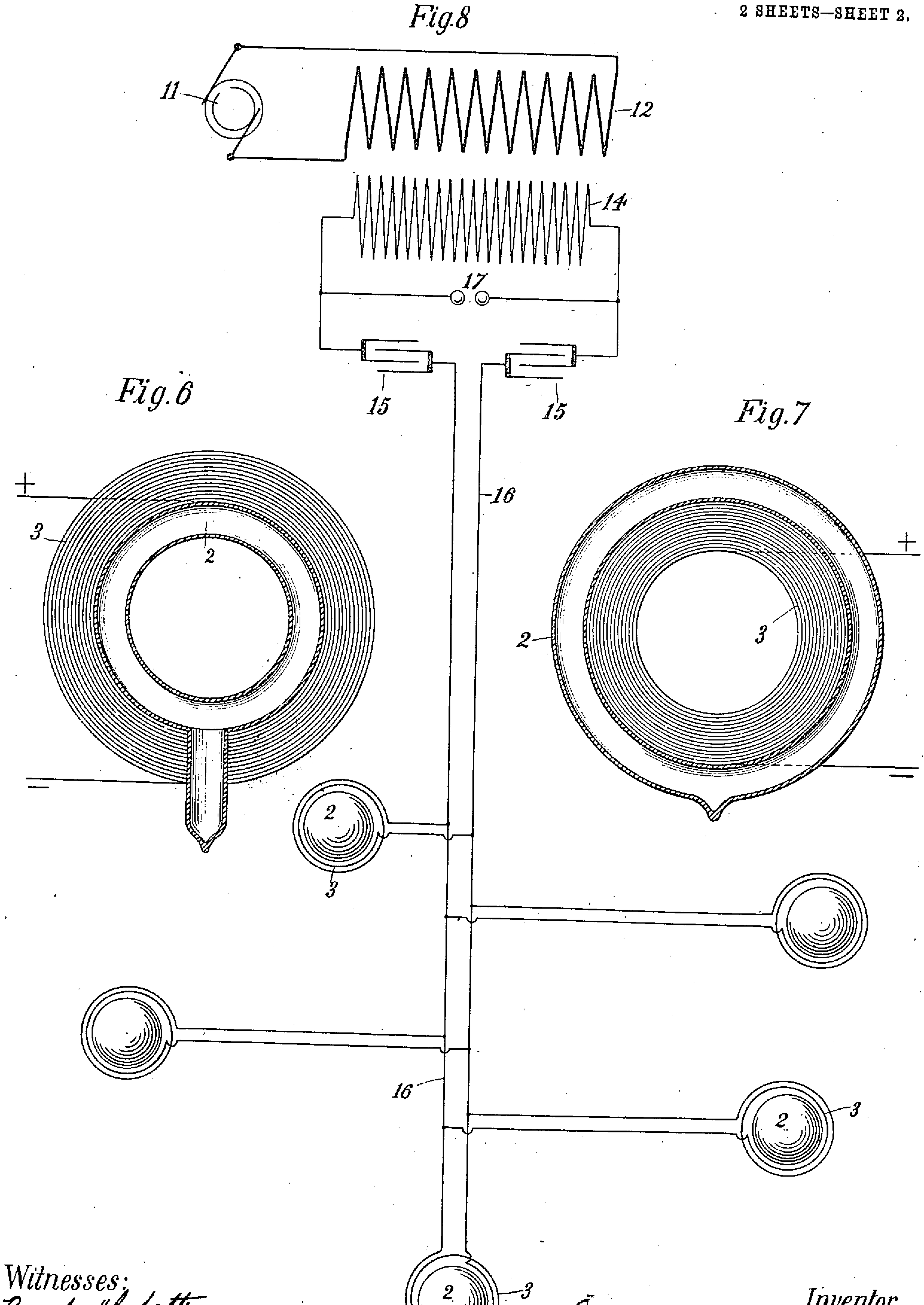
2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

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

INDUCTION VAPOR OR GAS ELECTRIC LAMP.

No. 843,533. Specification of Letters Patent. Patented Feb. 5, 1907.

Application filed April 18, 1900. Serial No. 13,291.

To all whom it may concern:

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

The existing state of the art of lighting by electricity presents various forms of lamps and methods of lighting, in all of which the actual light-generating current is conveyed into the light-emitting inclosure or space by some form of conductor. In my lamp the actual light-generating current is induced in the medium where the light is generated, the current being what is known as a "secondary" current.

The object of my invention is to provide a lamp and method of lighting which shall yield a practical light without any conductor leading into the lamp, thus making it possible to dispense with any break or joint in the electric circuit. This I accomplish by using vapor or gases of proper character and under proper conditions as the medium for transforming the electric energy into light, the energy being caused to be present in the vapor or gases which serve as a conductor by induction. In this way I dispense with conductors leading into the contained vapor or gas through the walls of the container.

It may be generally stated that a coil of wire traversed by a varying current of electricity is surrounded by a varying magnetic field consisting of so-called "magnetic" lines of force. The field of force thus established, however, varies in proportion with the variations of the current, and if a closed circuit—such, for instance, as a coil of wire—be properly placed within this varying field of force there will be induced in it a current corresponding to the variations in the field of force. A device of this character is usually termed an "induction-coil" or "transformer." If there be substituted for the secondary coil of the transformer a closed circuit of some vapor or gas of the proper character and under the proper conditions, it will act as a conductor, and the energy of such current will be induced in it if the rate of change is suitable. The energy of such current will manifest itself in the form of light and heat if sufficient lines of force are cut by the vapor to overcome its reluctance to become a conductor.

The induced current in the lamp and its voltage depend upon the general laws of induction—namely, the relation of the turns in the primary to those in the secondary and the rate of change of the pulsations or variations in the actuating or primary current, or, in other words, the rate at which the magnetic lines due to the primary current are cut by the secondary circuit. This rate is the measure of the electromotive force given to the secondary circuit. In the form of lamp which I have devised it is practicable to employ for the secondary circuit a simple closed circuit of vapor having effectively one turn, in connection with a multiple-turn primary, giving a suitable ratio of step-down transformation.

For the purpose of developing an electromotive force in the secondary sufficient to place it in a state where it will become readily conductive—that is, a true vapor conductor of low resistance—I make use of a current of such quantity and rate of variation in a primary of such multiplicity of turns and such interlinkage as will induce in one turn of a secondary an electromotive force which shall be sufficient to break down the tendency of the vapor to resist becoming a conductor notwithstanding the decrease of electromotive force which must result from the use of such multiple-turn primary as will give the required interlinkage with the said vapor secondary.

The vapor which I find most convenient in use is that obtained from mercury, because of its low resistance; but other materials may be used, the use of any vapor being dependent only upon the requirement that there shall be induced in it a voltage sufficient to overcome its resistance. Certain impurities or vapors added to the vapors which are selected for forming the secondary or light-emitting circuit exercise such a reluctance to the passage of the electric current that it is almost impossible with the most rapid variation of current to induce a secondary current in the lamp when they are present. Such vapors as will be obtained from water and some oxygen compounds seem to have this state of non-conductivity in a marked degree; also, the vapors usually present in a globe until it has been exhausted, heated, and the current induced in it, which current liberates more non-conducting vapors, would seem to render the desired state of conductivity almost impossible to attain; but by properly preparing the lamp and supplying the globe with the conducting-vapor freed from the objectionable ones a condition is reached where a practical and enduring lamp is obtained. The conducting-vapor when in its conducting state being a conductor requiring a rate of change in the primary that will induce in a secondary of one turn an electromotive force of, say, from three to fifty volts per inch in case the secondary is, say, three inches in diameter, the inducing-current need not be over a few hundred volts when the current is passing in the vapor, the voltage depending upon the material of the vapor, its density, and other conditions. The amount of light emitted by the gas readily shows at what time during the process of manufacture the lamp is completed.

I am aware that others have proposed certain lamps claimed to be induction-lamps having a luminous band induced therein; but in none has any considerable amount of light been produced. My lamp yields a large quantity of light and possesses other characteristics which clearly distinguish it from the faint luminosity of the electrostatic effect produced in the lamps above alluded to. The difference is also at once apparent in the source of current.

The invention will be described more in detail in connection with the accompanying drawings.

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 are views showing other forms of lamp. Fig. 8 is a diagrammatic view of several lamps and a form of generator in circuit therewith.

Referring to the drawings, 1 is any suitable source of rapidly-varying currents, and 2 is a closed container, the shape of which may be varied to suit the circumstances. Within the vessel 2 there is placed the desired vapor or gas of suitable density to be rendered light-radiant or light-emitting. 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 energizing-coil 1. On the passage of a current of the proper character through the coil 3 a current is induced in the vapor. Immediately the vessel becomes brightly luminous. A change in position of the primary coil causes a corresponding change in the position of the luminosity. By increasing the amount of energy imparted from the primary source practically all of the vapor in the lamp may be made to act as a secondary and to give the lamp a very intense brightness. The addition of a second coil 4 on the globe of the vessel 2 (see Fig. 2) causes an increase of luminosity.

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 with reference to Fig. 1.

In Fig. 4 a form is shown consisting of two hemispherical bulbs 2 2, having suitable depressions in their faces for receiving the coil 3. The bulbs are then placed together with the coil 3 between them, and currents through this 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.

As already stated, the vapor which I find very convenient for use is that of mercury. This vapor offers a low resistance and produces a very intense white light. Other gases or vapors may, however, be used, care being taken to select such as will receive current under the influence of such a voltage as may be induced therein, and the light emitted thereby will correspond to the spectrum of that gas or vapor.

The operation of the lamp depends upon the possibility of obtaining a current of suitable rate of variation. I have obtained excellent results by the use of the discharge-currents obtained from condensers; but a properly-constructed mechanical generator would produce the necessary current.

In Fig. 8 I have represented diagrammatically one form of apparatus giving a rapidly-varying current suitable for use to operate my lamp. This generator is indicated at 11 and produces an alternating current of, say, one hundred and twenty-five to three hundred periods and of a voltage of, say, from fifty to one hundred volts. The generator supplies the primary coil 12 of a transformer, the secondary coil 14 delivering an induced current of, say, six thousand volts. This induced current is delivered to condensers 15 of suitable capacity, which may be arranged to be discharged through the line 16. I usually prefer, however, to use two condensers 15 15, as shown, using the current induced between them through the line 16. The discharge-gaps 17 limit the charge of the condensers and serve to discharge them. Other forms of discharge devices may be employed—as, for instance, the well-known vapor-discharge devices disclosed in many of my early patents and applications. Each 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 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 six thousand volts and a bulb six inches in diameter a coil 3 of fifteen turns will serve to illuminate the bulb. With bulbs having other characteristics the best number of turns may be determined by trial.

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 exhaustion. I then introduce 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, Fig. 2, in such position that its field may include the bulb and its inclosed vapor. There is then passed through this primary coil a rapidly-varying current, and the effect upon the vapor 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. It is then sealed off from the pump and is finished. The light produced by this lamp is an intensely-luminous light in distinction from the foggy or hazy condition which may be produced by means of electrostatic effect. In the production of my lamps this foggy or hazy effect is produced during their preparation, usually during the period of exhaustion before the density of the ultimate conducting-vapor has been regulated and always in highly-rarefied gases with exceedingly-rapid rate of variation of the current obtained from the use of small condensers and very high voltage. This electrostatic effect usually appears striated radially in a band in the tube, the striations appearing like the open spaces in an ordinary carriage-wheel.

In the production of the lamp herein claimed the intensely-luminous condition is accompanied by a material change in the operation of the system from that which occurs so long as the foggy or hazy condition persists. During the last-named state there is an oscillatory condition throughout the system, the discharges of the spark-gap being accompanied by an oscillatory action of the condenser-circuit; but when the true conductive condition of the lamp as a secondary is reached the oscillatory action of the circuit practically ceases, owing to the fact that the secondary practically absorbs all the energy of the system at the first alternation of the discharge. This emphasizes the difference in the action between the results obtained in the methods heretofore employed in the art and that obtained by me. This true conductive condition may be further demonstrated by bringing the primary coil gradually into closer relationship to the secondary or lamp circuit and then gradually moving it away. It will be found that the maximum luminosity of this conductive condition of the secondary will not appear until the primary is brought into close relation to the lamp.

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 vapor 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.

The invention claimed is—

1. A gas or vapor device consisting of an inclosing chamber, a gas or vapor contained therein of such density and electrical resistance as to become conductive of electric currents and to constitute the secondary circuit of an electric transformer, a primary coil therefor, and means for transmitting rapidly-varying electric currents through the primary, the number of turns of said coil and the quantity and rate of variation of said currents, being predetermined with respect to the characteristics of said gas or vapor so as to induce therein currents of sufficient quantity to cause said vapor to conduct current in the low-resistance condition.

2. A vapor or gas device having an inclosing chamber, a primary exciting-coil, the vapor or gas constituting a secondary circuit for said primary, the vapor or gas having such quality as to be traversed by induced electric currents and absorb practically all the energy from an oscillatory circuit in the

first oscillation, and means for transmitting rapidly-varying electric currents through the primary, thereby rendering the secondary luminous.

3. The combination of a gas or vapor having an inclosing chamber, a primary coil in inductive relation thereto, a secondary therefor consisting of said inclosed gas or vapor having such density and resistance as to convey currents of sufficient wattage as to be rendered highly luminous under the influence of said currents, means for transmitting rapidly-varying electric currents through said primary coil, and thereby inducing currents in the secondary, the length of the primary coil being so proportioned to the electrical conditions of the circuit that variations in the current flowing in the primary will be in direct proportion to the current absorbed by the secondary.

4. In a system of electric lighting, two or more primary coils connected in parallel, gas or vapor inclosing chambers in inductive proximity to the respective primary coils, secondary circuits in the respective inclosing chambers consisting of conducting vapor or gas of such density and resistance as to conduct induced currents under the influence of rapidly-varying currents supplying the respective primary coils, and thereby inducing a flow of currents in said secondaries, the primary coils and the source being so proportioned with reference to each other and to the respective secondaries that the currents flowing through the primaries shall vary in approximately direct proportion to the currents absorbed in the secondaries.

5. A source of rapidly-varying electric currents of approximately definite quantity, and a localized field actuated by said currents, in combination with an inclosed gas or vapor in inductive relation to the field, the said gas or vapor having such a density and conductivity that it is adapted to absorb practically all the energy of said primary currents at each alternation.

6. A source of rapidly-varying electric currents of approximately definite quantity, and a localized field to which said currents are applied, in combination with an inclosed gas or vapor in inductive relation to the field, the density and conductivity of the gas or vapor being specifically adapted to the applied currents so that the gas or vapor will become a low-resistance conductor and light-radiant by the electromagnetic inductive effect of said currents on said field.

7. The combination with a source of dynamic electricity, and means for transforming the current into rapidly-varying current, a localized field to which said rapidly-varying currents are applied, a body of gas or vapor in said field of such volume, density, and conductivity, as to absorb by electromagnetic induction and to transform into heat, light, &c., all the energy of said field at each variation of said currents.

8. The combination with an electric circuit carrying dynamic currents of quantity, of means for transforming the same into rapidly-varying currents, independent localized fields created by said rapidly-varying currents, and an inclosed gas or vapor in each field of such volume, density, and conductivity as to be capable of absorbing the energy present at each variation of the field.

9. The combination with an electric circuit carrying dynamic currents of quantity, of means for transforming the same into rapidly-varying currents, independent localized fields created by said rapidly-varying currents, an inclosed gas or vapor in each field of such density as to be capable of absorbing and transforming into light the energy present at each variation of the field.

Signed at New York, in the county of New York and State of New York, this 23d day of March, A. D. 1900.

PETER COOPER HEWITT.

Witnesses:

WM. H. CAPEL,

CHARLES B. HILL.