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P. C. HEWITT.

APPARATUS FOR TRANSFORMING ELECTRICAL ENERGY.

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Fig. 1.

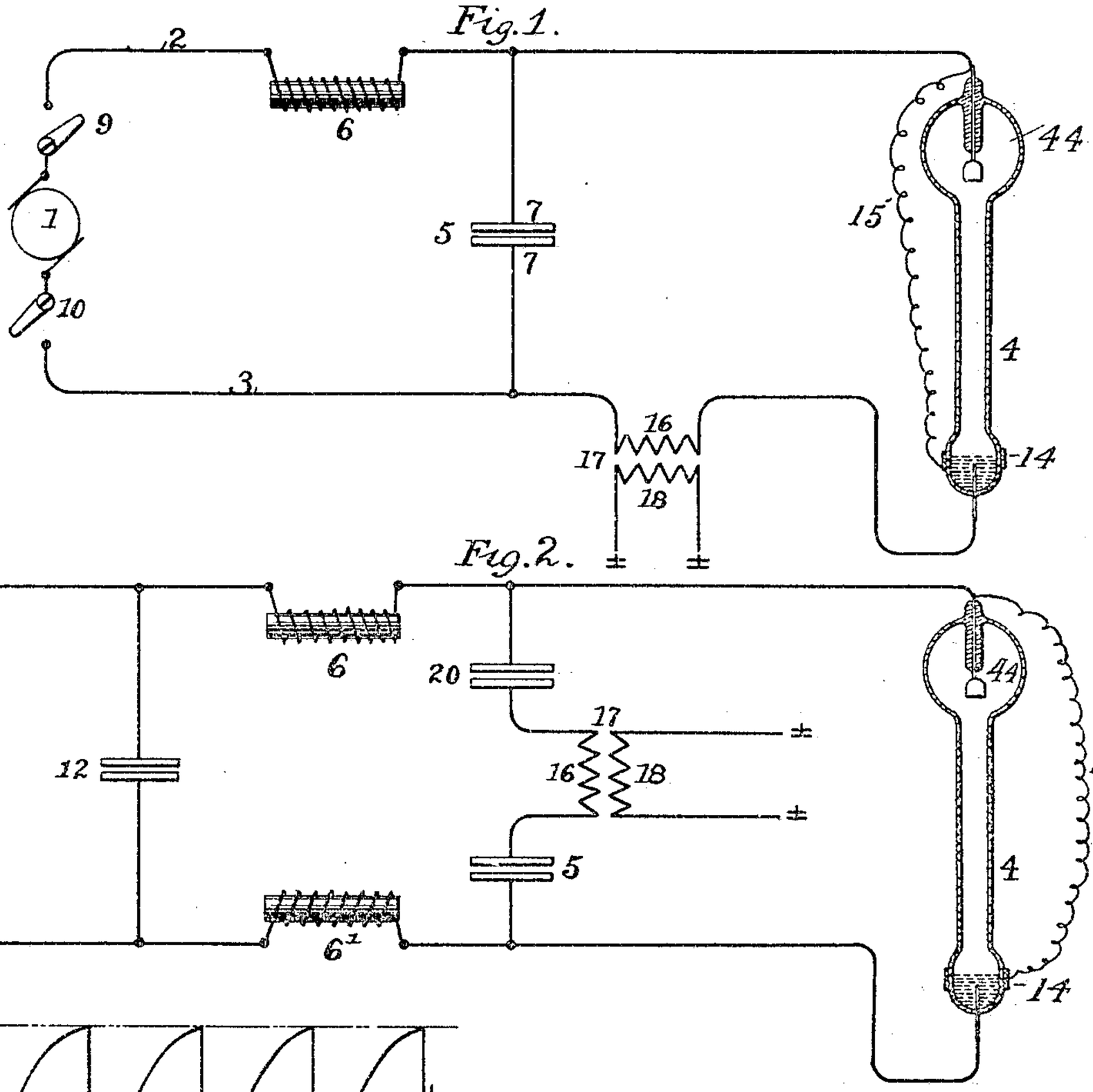

Fig. 2.

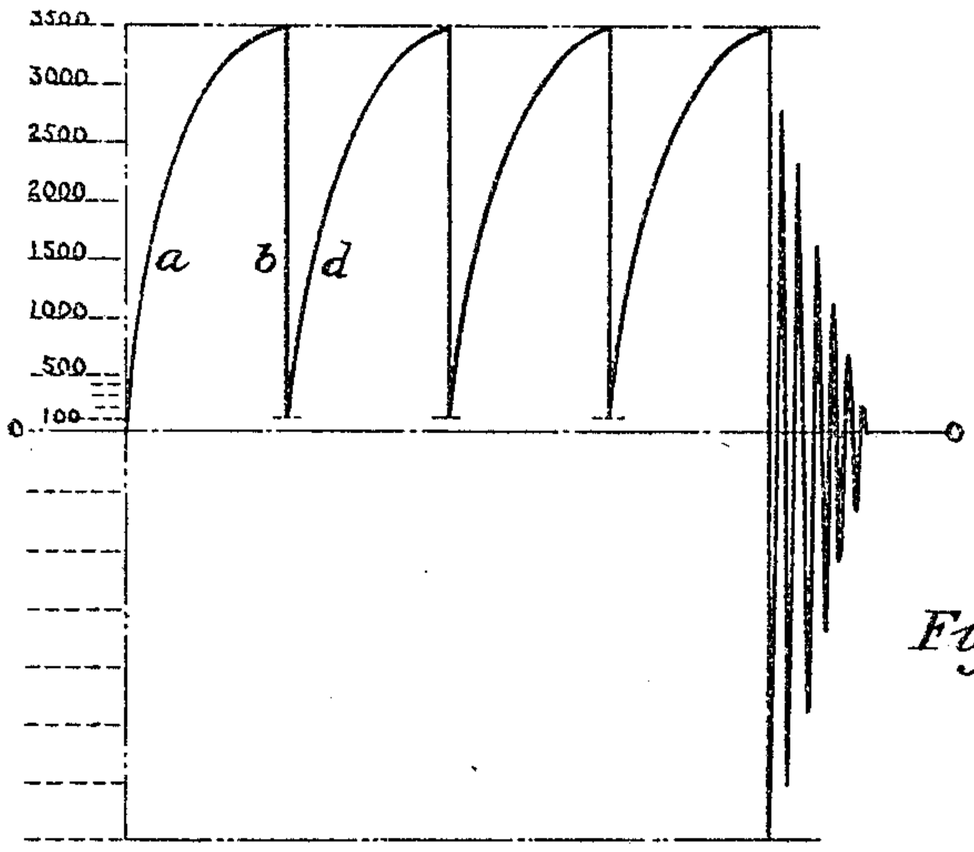

Fig. 3.

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No. 781,603. Patented January 31, 1905.

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.

APPARATUS FOR TRANSFORMING ELECTRICAL ENERGY.

SPECIFICATION forming part of Letters Patent No. 781,603, dated January 31, 1905.

Original application filed April 25, 1902, Serial No. 104,608. Divided and this application filed September 24, 1902. Serial No. 124,624.

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 Apparatus for Transforming Electrical Energy, of which the following is a specification.

I have found that when an inclosed gas or vapor of suitable character and density contained within a holder of suitable character and dimensions and having appropriate electrodes is connected in an electric circuit there will be opposed to the passage of electric current an initial resistance which may be overcome by an electromotive force of sufficient value, the gas or vapor then serving as a conductor across the gap in the metallic circuit, when the proper conditions of current are supplied. This initial resistance appears as if a self-created electrical resistance phenomenon at the negative electrode, which on being overcome removes itself without any appreciable energy loss. The resistance which the gas or vapor shall offer to the current during the period of discharge may be made of practically any desired value within wide limits, while the initial resistance above referred to can also be made of any desired value each independently of the other. In other words, it is possible to so construct an apparatus of this sort as to present initially a very high resistance to the passage of the current and to present a very low resistance to the current after it has once been established through the apparatus. Should other conditions be required, both these factors may be varied by altering the construction of the apparatus in the first instance. Assuming, however, a low resistance during the discharge period and a desired initial resistance, the amount of work done in the vapor-gap is practically very small. Accordingly an apparatus of the kind described can be economically used in place of a spark-gap, possessing, by reason of the features above mentioned, a very great advantage over the ordinary air-gap and a still greater advantage over a Wehnelt interrupter. The described factors having once been fixed may be kept at their normal value by maintaining a constant temperature of the inclosed gas or vapor. The means for maintaining such a temperature as well as the means for controlling and determining the other factors hereinbefore mentioned are fully set forth in certain patents issued to me on the 17th day of September, 1901. If desired, special means for maintaining a constant temperature may be applied to the apparatus when it is used in place of a spark-gap. Inasmuch as the electrodes remain practically unchanged by repeated use and the whole apparatus is substantially unaltered, a single apparatus will operate without any need of attention or repair. Should it be desired to provide a higher initial resistance, so as to increase the rise of potential in the discharge-circuit, a new apparatus can be substituted calling for such higher potential at the start; but this new apparatus may, like the first, consume little or no current during the discharge period. These elecric circuit-breakers may be used in series or parallel, and in case it is not desired to have the initial resistance to starting so great it may be modified by starting-bands at the electrodes, as described in my patents, and in case it is desired to operate several breakers in parallel they may be timed by connecting the starting-bands or groups thereof together. In these respects the described apparatus is superior to the ordinary air-gap, in using which it is necessary to keep the terminals of the conductors or balls smooth and polished and in which any increase in the initial resistance (as by the separation of the balls or conductors) also entails an increase of resistance during the period of discharge, and, further, the resistance during the discharge period may be lower and is far better than a Wehnelt interrupter on account of the great loss of energy in the Wehnelt interrupter.

Another feature of my apparatus is that the gas between the electrodes acts as a true vapor-conductor after the circuit is once

established through the vapor, and when this conductor is made of very low resistance practically a short circuit is formed. Since the vapor-resistance factors are known and the conditions they are subject to, the action can always be depended upon. By the passage of current the electrical pressure or voltage is lowered to a point where the resistance to starting re-forms, whereupon the checked current rebuilds or reëstablishes itself, its electrical pressure rising until the breaking-down pressure is again attained, after which the same succession of actions are repeated.

By utilizing the described apparatus in the manner indicated periodic currents of high frequency can be produced by reason of the fact that its action is very quick and uniform. It is especially adapted to the work of creating currents of definite time periods and rapid alternations. I have found, for instance, that with a device consisting of an inclosed mercury-vapor organized in the manner described in my patents above referred to and provided with a condenser and a reactive device suitably placed and adjusted with reference thereto it is possible to produce such currents, the action being in the first instance to apply to the terminals of the vapor-gap a potential difference sufficient to overcome the initial resistance, whereupon a rapid fall of potential takes place until it reaches a point where it is insufficient to overcome the reduced resistance at the vapor-gap. At this point the current ceases to flow, the break in current-flow being abrupt on account of the immediate reëstablishment of the initial resistance of the vapor. Thereafter the applied potential rises until it reaches the breaking-down pressure of the initial resistance and then the same cycle of operations is repeated. The intermittent or vibratory currents produced in the circuit by the circuit-breaker thus described may be applied to use in the vapor or gas gap itself, or they may be applied to other apparatus, or to both simultaneously. For example, one application of the present invention would be to serve the purposes of furnishing a periodic current for wireless telegraphy and another for producing rapidly-varying currents for the purpose of producing light by induction, and still another application would be that of producing light, say, in the vapor-gap itself by means of successive electrical impulses of relatively high electromotive force, causing a high illumination of the vapor or gas at such rapid intervals that the physiological impression is that of continuous illumination. In making the last-named application of my invention I cause the intermittent currents produced by the intermittent action of my apparatus to act upon the vapor in the gap in such a way as to produce a brilliant light. To this end the density of the vapor and the dimensions of the container are suitably proportioned to each other for this purpose, as set forth in a general way in my patents of September 17, 1901; but whereas in the inventions set forth in the said patents the vapor is intended to be affected by a flow of current of given value at a certain potential the purpose in the present instance is to affect the gas or vapor by an intermittent flow of a current of practically the same value, but of higher potential, the energy represented by the intervals between the impulses being intermittently withdrawn from action and reappearing in the form of an increased quantity in the rapid periodic currents. The result is an increased brilliancy on the part of the lamp due to this increased consumption of energy per unit of time, while the effect upon the eye becomes that of a light due to a continuous flow of current of greater quantity.

In the accompanying drawings, illustrating an application of my invention, Figure 1 is a diagram showing a general organization of the apparatus. Fig. 2 shows a modification, and Fig. 3 is a theoretical diagram.

Referring to the drawings, 1 represents any convenient source of electrical energy—say, for instance, a continuous current-generator, (which for convenience it may be assumed in this particular instance to be of three thousand five hundred volts.)

2 and 3 represent main conductors leading from the generator.

4 represents an electric lamp of the character described in my patents hereinbefore referred to. This is connected at any convenient point between the conductors 2 and 3.

A condenser 5 or other suitable device or means for affording an electrical capacity is connected across the terminals of the lamp 4. An inductive resistance 6 is connected in the line 2 between one plate 7 of the condenser 5 and the source 1 of current. It is to be understood that by referring to a "condenser" I mean to include other suitable means for securing the requisite electrical capacity.

Assuming that the circuit of the generator is closed by the switches 9 and 10, there will be a sudden rush of current through the lines 2 and 3, tending to charge the plates 7 7 of the condenser 5. The inductor-resistance 6 opposes a counter electromotive force to the applied electromotive force, thus temporarily resisting the flow of current beyond that resistance. The condenser 5 thus becomes gradually charged as the electromotive force at its terminals rises. Assuming that the lamp 4 will be traversed by a current under the influence of a difference of potential of three thousand five hundred volts, then as soon as the condenser 5 has attained its charge a current will traverse the lamp; but the moment such current does traverse the lamp the difference of potential at its terminal is enormously reduced. Practically it may be made

to drop as low as one hundred volts or even below twenty volts. Thereupon the condenser 5 discharges or feeds the circuit between itself and the lamp. The reactive coil 6 may serve to prevent at this time too great a discharge from the source of current. On the discharge of the condenser the passage of current through the lamp will cease and the operation be repeated, causing rapidly-succeeding impulses of current to traverse the lamp. Each succeeding impulse will be at a potential of, say, three thousand five hundred volts, and the light emitted by the lamp will be of a brilliancy due to the product of the average voltage into the current during the successive time intervals of current-flow. It is characteristic of these lamps that they may be constructed not to pass an appreciable amount of current below a given voltage, which can be predetermined, and therefore at the end of certain definite periods the current ceases to pass and the light goes out. Accordingly the lamp has a definite consumption period between the extreme higher limit of applied electromotive force and the lowest limit at which the lamp will take current. What is perceptible to the eye is the luminous vibrations due to these successive passages of current, the intervals of no current being undiscernable by reason of the rapidity with which the intervals follow each other. The period of the condenser may be further retarded by an inductance device placed in the condenser-circuit. An additional condenser 12, placed between the source and the condenser 5, may serve to assist the speed of charge and discharge through the inductance 6. A similar inductance 6′ may be included in the branch 3, if desired.

In my lamps the starting is usually facilitated by the use of a band 14, placed in the neighborhood of the negative electrode upon the exterior of the lamp and connected by a conductor 15 with the positive electrode or the conductor leading thereto and is useful where lower initial voltages are to be used. By inserting the primary coil 16 of a converter 17 in one of the conductors—for instance, 3, as shown in Fig. 1—an alternating current may be produced in a secondary circuit 18, which in turn may be used for any desired purpose. The primary coil 16 in this case may be utilized as the inductance device referred to above for retarding the period of the condenser-circuit.

In Fig. 2 I show the primary 16 of the converter 17 connected up between two condensers 5 and 20, connected in series across the terminals of the lamp 4.

In Fig. 3 I have shown in diagram the theoretical curve illustrative of the difference of potential and the changes therein which may occur in a circuit such as shown in Fig. 2. When the circuit is closed, there is a rise of potential at the terminals of the lamp from zero to three thousand five hundred volts, as shown by the portion *a* of the curve. Thereupon current traversing the lamp the condenser discharges, dropping the current to one hundred volts, as indicated by the portion *b* of the curve. The voltage then again rises to three thousand five hundred volts, as indicated by the portion *d* of the curve, the rate of charging being dependent upon the amount of self-induction or resistance in the circuit between the condenser and the source. By varying this self-induction the portion *d* of the curve may be made more or less abrupt, and by varying the inductive capacity of the circuit between the condenser and the lamp the portion *b* of the curve representing the operation of the lamp may be more or less prolonged. The lines drawn above and below the zero-line near the end of Fig. 3 are designed to illustrate the gradually-decreasing surgings of the condenser-current during the interval of discharge in its circuit.

By properly adjusting the capacity of the condenser, the circuit, and also the inductance almost any required definite period of charge and discharge may be secured. The condenser 5 may be made to act either by reason of its own natural period of oscillation or governed by the charge which it receives from the line as controlled by the line. The control of the output of the source may be derived from the secondary circuit of the transformer, the secondary coil thereof being adjusted in resonance rise with the primary, so that the oscillations in the secondary circuit may be capable of preponderating the periodicity of the system.

The currents developed in the circuit and hereinbefore described as utilized for increasing the luminosity of one of my lamps may in addition be used for other purposes, or the quality of my apparatus as a light-giving body may be fully subservient to the development of currents for other purposes. In other words, I may in some instances construct a gas or vapor apparatus having the primary object of controlling the rate of currents developed in the system, which currents may or may not operate to give light in the apparatus.

This application is a division of an application, Serial No. 104,608, filed April 25, 1902, in which claims are made for certain features of the apparatus herein described. In another application, Serial No. 104,607, filed April 25, 1902, claims are made upon certain of the methods of operation herein described, and in another application, Serial No. 214,901, filed July 1, 1904, claims are made upon a method of producing light described herein.

I claim as my invention—

1. The combination with a gas or vapor lamp having a gas-path capable of being rendered conductive under the influence of currents of a given potential and remaining conductive under the influence of currents of a less poten-

tial, of a source of electric currents, and means for periodically applying to the terminals of the lamp differences of potential varying from the higher potential to a value less than said lesser potential, substantially as described.

2. The combination with a gas or vapor lamp having a gas or vapor path capable of being rendered conductive under the influence of currents of a given potential, and remaining conductive under the influence of currents of a less potential, of a source of electric currents, a condenser connected in parallel with the lamp, and a retarding device connected between the source and the condenser, substantially as described.

3. A source of electrical capacity, a discharge-circuit therefor, a gas or vapor lamp included in and constituting a portion of the discharging circuit, means for causing successive discharges in the said circuit, the said lamp offering to the discharge in the circuit a medium which is a comparatively good electrical conductor and which becomes luminous by reason of the successive discharges therethrough.

Signed at New York, in the county of New York and State of New York, this 15th day of September, A. D. 1902.

PETER COOPER HEWITT.

Witnesses:

REGINALD BELFIELD.

WM. H. CAPEL.