No. 644,995. Patented Mar. 6, 1900.

# D. McF. MOORE.

## VACUUM TUBE LIGHTING.

(Application filed Nov. 9, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

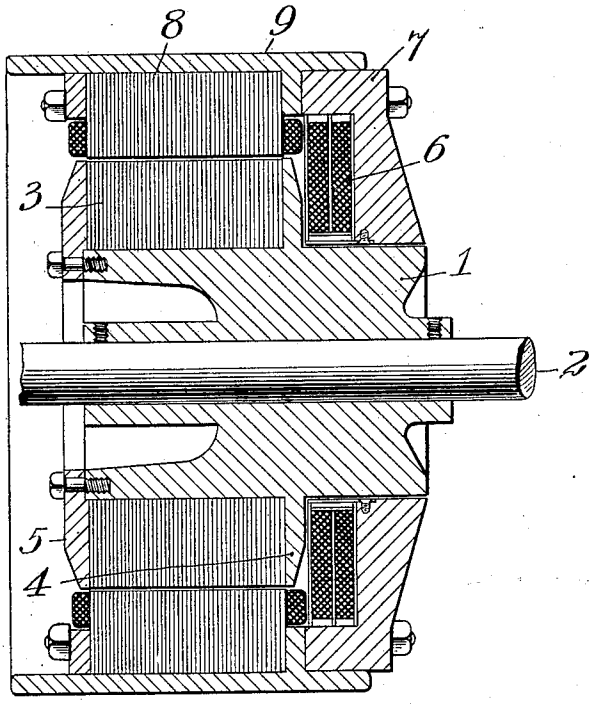
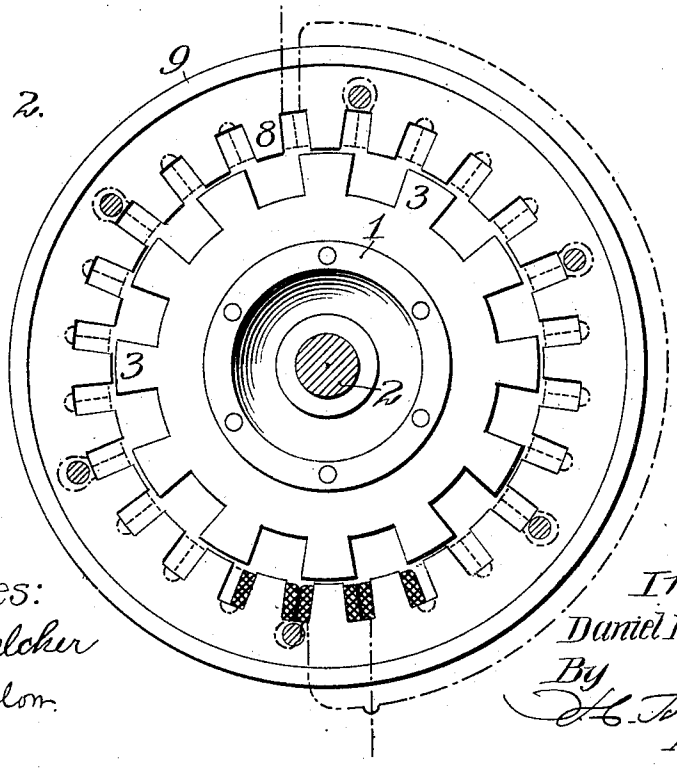



Fig. 2.




Witnesses:
C. L. Belcher
M. J. Ludlow

Inventor
Daniel McFarlan Moore
By H. Townsend
Attorney

No. 644,995. Patented Mar. 6, 1900.

D. McF. MOORE.

VACUUM TUBE LIGHTING.

(Application filed Nov. 9, 1899.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3

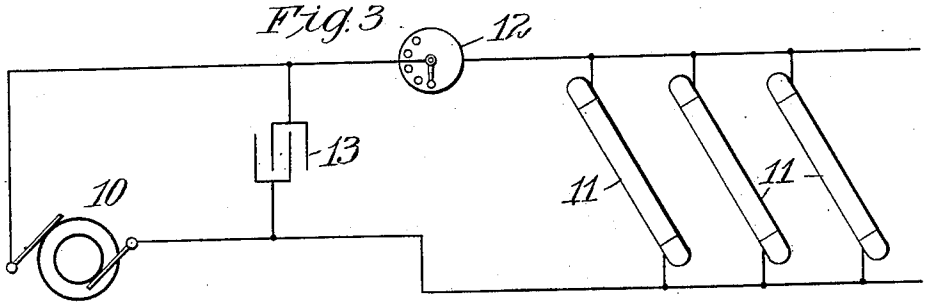



Fig. 4.

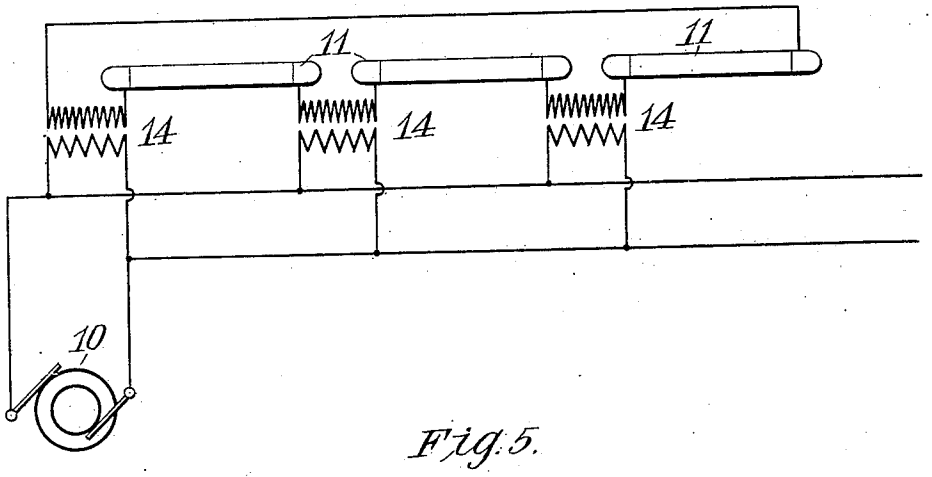



Fig. 5.

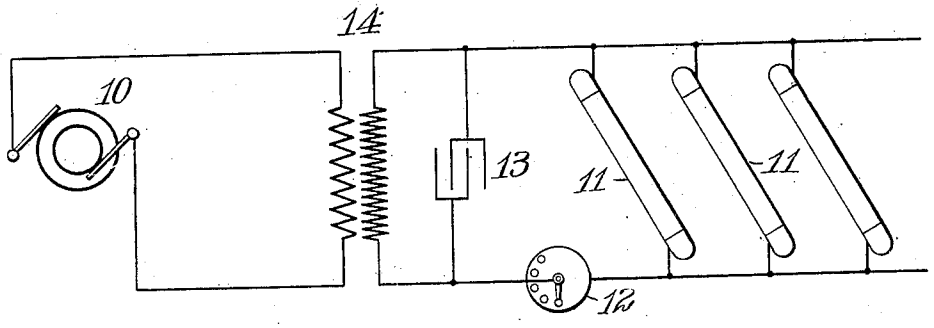



Fig. 6.

Witnesses:
C. G. Belcher
M. J. Ludlow.

Inventor
Daniel McFarlan Moore
By
H. C. Townsend
Attorney

# UNITED STATES PATENT OFFICE.

DANIEL McFARLAN MOORE, OF NEWARK, NEW JERSEY, ASSIGNOR TO THE MOORE ELECTRICAL COMPANY, OF NEW YORK, N. Y.

## VACUUM-TUBE LIGHTING.

SPECIFICATION forming part of Letters Patent No. 644,995, dated March 6, 1900.

Application filed November 9, 1899. Serial No. 736,336. (No model.)

*To all whom it may concern:*

Be it known that I, DANIEL McFARLAN MOORE, a citizen of the United States, and a resident of Newark, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Vacuum-Tube Lighting, of which the following is a specification.

My invention relates to those systems of electric lighting wherein the lamps consist of sealed glass tubes or other forms of receptacle containing rarefied air or other gas and are excited to luminosity by electric vibrations, waves, or disturbances of high frequency, obtained from any desired source.

The object of my invention is to simplify the system and improve its efficiency, to which end I propose to excite the tubes or lamps, directly or indirectly, (through a transformer,) by alternating currents or electromotive forces produced by a dynamo-machine specially constructed or organized to generate an alternating impressed electromotive force that rises and falls with great abruptness, or, in other words, an electromotive force in which the rate of change of each wave or pulse is exceedingly high. Graphically represented, the best realization of such an alternating wave of electromotive force would be a square-topped wave of electromotive force, as represented in Fig. 6 of the accompanying drawings, although in practice the wave obtained would necessarily vary considerably from that form and be represented as more closely following a true wave form, owing to the effects of inductance or magnetic lag in the generator.

The invention consists, further, in the combination, with the tubes or lamps, of an alternating-current dynamo especially constructed to produce alternating electromotive forces of high frequency without excessive losses from heating or hysteresis when run at high speed, and to this end organized so that the total magnetic flux in this machine shall be at all times approximately the same.

The invention consists, further, in the combinations of apparatus specified in the claims.

In the accompanying drawings, Figure 1 is a sectional elevation of a form of dynamo-machine especially adapted to the purposes of my invention. Fig. 2 is an end elevation of the rotor and stator of said machine. Figs. 3, 4, and 5 illustrate diagrammatically organizations of apparatus embodying my invention. Fig. 6 shows graphically the form of impressed electromotive force which I aim to generate in the dynamo-machine used for directly exciting the vacuum-lamps.

Referring to Figs. 1 and 2, the rotor or revolving armature of the machine consists of a revolving mass of iron 1, secured to a shaft 2 and having a radially-projecting portion or flange terminating in polar projections or teeth 3, formed at the edge of a series of disks clamped in position between a flange 4 and a clamping-plate 5. The exciting coil or coils of the machine (indicated at 6) surround the axis of the rotor. They are preferably fixed and suitably supported in the stationary end plate or frame 7 of the machine. The rotor revolves without having any attached wires upon its periphery and may be, therefore, run at very high speed. The laminated poles 3 thereof are presented to the laminated poles 8 of the stator, said latter poles being formed in the edge of a series of plates clamped in a ring or drum 9, of iron, and all bolted to the iron end plate or frame 7, through which the magnetic circuit is completed. The poles 8 are wound with a series of generating-coils connected up in any desired fashion and supplying the alternating electromotive force to the lamps. The polar faces of the projecting poles 3 and 8 are provided with perfectly-square corners or projections and are in as close propinquity as possible, the aim being to cause the magnetic flux in the wound poles to rise and fall as abruptly as possible, and to thereby generate an electromotive force whose rate of change shall be as rapid as possible, and thereby be better adapted to excite luminosity in the vacuum-tubes. Theoretically the form of varying electromotive force best adapted to the purpose would be as represented in Fig. 6, where each pulse is indicated as rising in electromotive force from zero to a maximum in a zero interval of time, which is, of course, not realizable in practice and would only be approximated by the machine described. In any case, however, the aim should be, in or-

der to obtain the best results, to so construct the dynamo as to produce an electromotive force each pulse of which will rise in potential with great abruptness, and this is the object of constructing the polar projections with the square corners, as shown. As will be seen, the number of poles in stator and rotor, respectively, is different, so that there are provided intermediate poles (wound) in the stator in which there is alternately a magnetic flux and cessation of magnetic flux; but the lengths of pole-faces in the rotor are such as to extend from the middle of one stator-pole to the middle of the next, so that as the flux in one is diminished by the rear portion of the rotor-pole uncovering a stator-pole the flux in the next pole will correspondingly increase, thus keeping the total flux in the magnetic circuit of the machine constant, and avoiding thereby to a very great extent the losses from hysteresis and heating.

In the diagram Fig. 3 I show an organization of apparatus embodying my invention and in which the machine already described is especially useful. The vacuum-tube lamps (indicated by the numeral 11) are connected across the circuit-wires leading from the alternating-current dynamo 10 and are in direct conducting connection therewith, so as to receive the impressed electromotive forces generated therein of high frequency and to be thereby rendered luminous. In practice good results may be obtained by using a frequency of eight hundred periods per second, for the production of which the machine already described is especially suited. A voltage in the machine itself of as low as two thousand volts or even lower may be satisfactorily employed. The vacuum-tubes themselves are furnished with conducting-caps at their ends, which caps may be of tin-foil cemented to the tube or may be conducting paint or cement embodying graphite or other good conductor. The tubes thus formed give considerable capacity to the circuit and permit the employment of high-resonance effects, either with or without the use of an artificial condenser added to the circuit, as indicated at 13. At 12 is indicated an adjustable inductance placed between the circuit-wire leading to the lamps and the point of connection of the condenser. This adjustable inductance is employed for tuning the circuit of lamps to resonance with the period of impressed electromotive force, thereby giving increased luminous effects in the lamps.

In the modified arrangement indicated in Fig. 5 the lamps are indicated as connected with the machine 10 through the potential-raising converter or transformer 14, the arrangement being in other respects substantially the same as in Fig. 3, in that the alternating electromotive forces generated by the dynamo are the exciting electromotive forces for the lamps directly applied in Fig. 3, but indirectly by induction and raising of potential in Fig. 5. In the latter arrangement the potential of the machine may be only one hundred volts and the converter 14 be potential raising in the ratio of one to twenty, so as to give two thousand volts on the lamp-circuit.

Fig. 4 shows a modified arrangement wherein the converters 14 have their primaries connected in multiple to the wires leading from the machine and their secondaries connected in series with the lamps, as shown, each lamp being interposed between two secondaries.

While I have shown one form of machine adapted to produce a suddenly-varying electromotive force and have described the same as entering into the organizations of apparatus shown in Figs. 3, 4, and 5, I do not wish to be understood as limiting myself to the use of that form in those organizations.

The invention claimed is—

1. In a system of vacuum-tube lighting, the combination with the tubes to be excited, of an alternating-current generator in direct conductive or inductive connection therewith, and organized as described to produce an alternating impressed electromotive force of abruptly-changing value.

2. In a system of vacuum-tube lighting, the combination with the tubes or lamps containing a rarefied gas, of an exciting-dynamo having a rotor composed of a revolving mass of iron having unwound radially-extending polar projections and an exciting-coil surrounding the axis on which the rotor revolves, and having a stator the iron of which is extended around to the opposite end of the rotor to complete the magnetic circuit as and for the purpose described.

3. A vacuum-tube lighting apparatus comprising lamps consisting of glass tubes or other forms of receptacle containing rarefied air or other gas provided with conducting caps or electrodes and an alternating-current dynamo-electric machine for exciting said lamps to luminosity, said machine having a rotor and stator whose polar teeth or projections have their opposing faces proportioned as described to give a constant magnetic flux in the machine.

4. In a system of vacuum-tube lighting the combination with the tubes to be excited, of an exciting alternating-current dynamo-machine whose revolving element has unwound polar teeth or projections and which is constructed as described to generate an alternating electromotive force of abruptly-changing value while maintaining an approximately constant total magnetic flux.

5. A vacuum-tube lighting apparatus comprising in combination an alternating-current dynamo whose rotating element consists of a mass of iron terminated in unwound polar projections or teeth which in their rotation act upon suitable generating-coils, and lamps consisting of glass tubes or other forms of receptacle containing only rarefied air or other gas and provided with exterior conducting caps or electrodes connected directly or indi-

rectly with the generating-coils of the machine, as and for the purpose described.

6. An electric-lighting apparatus comprising an alternating dynamo whose rotor consists of a revolving mass of iron terminating in unwound polar teeth or projections which operate upon fixed generating-coils, a transformer whose primary is joined to the said generating-coils, and a secondary for said transformer joined to lamps which consist of sealed glass tubes or other forms of receptacle containing rarefied air or other gas and provided with exterior conducting caps or electrodes.

7. In an electric-lighting apparatus, the combination of an alternating-current dynamo, electric lamps consisting of sealed glass tubes or other forms of receptacle containing rarefied air or other gas and provided with conducting caps or electrodes, the lamps being connected directly or indirectly with the dynamo so as to be excited by the alternating electromotive force thereof, and an adjustable inductance connected to the circuit of the machine and lamps.

Signed at New York, in the county of New York and State of New York, this 20th day of October, A D. 1899.

DANIEL McFARLAN MOORE.

Witnesses:

DELBERT H. DECKER,

M. J. LUDLOW.