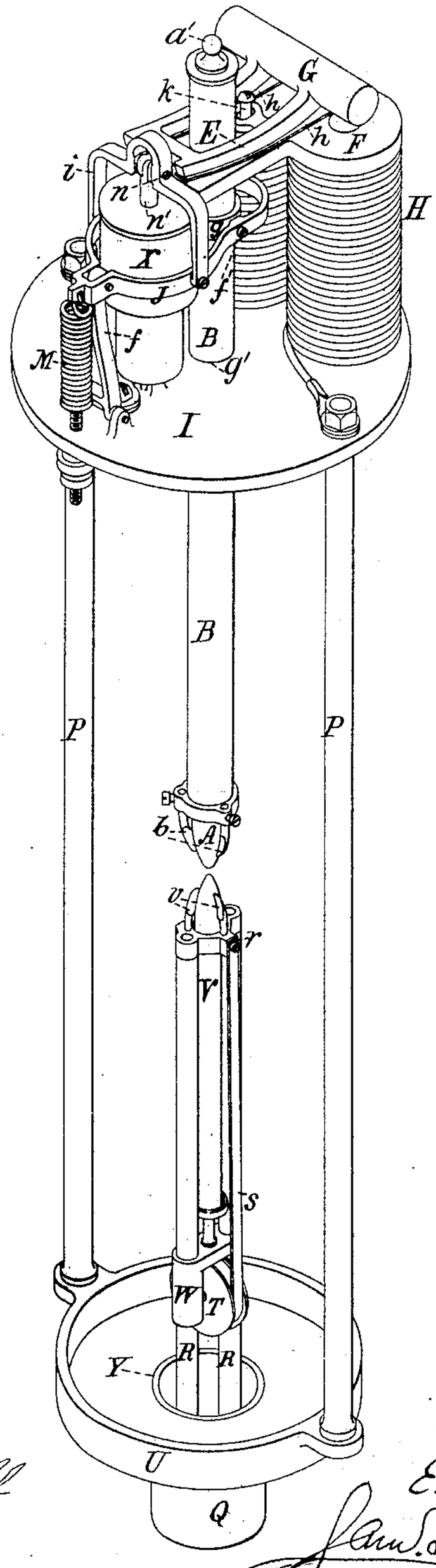
2 Sheets—Sheet 1.

G. W. FULLER & E. D. MACKINTOSH.

Electric Lamp.

No. 229,246. **Patented June 29, 1880.**

FIG. 1.



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2 Sheets—Sheet 2.

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FIG. 2.

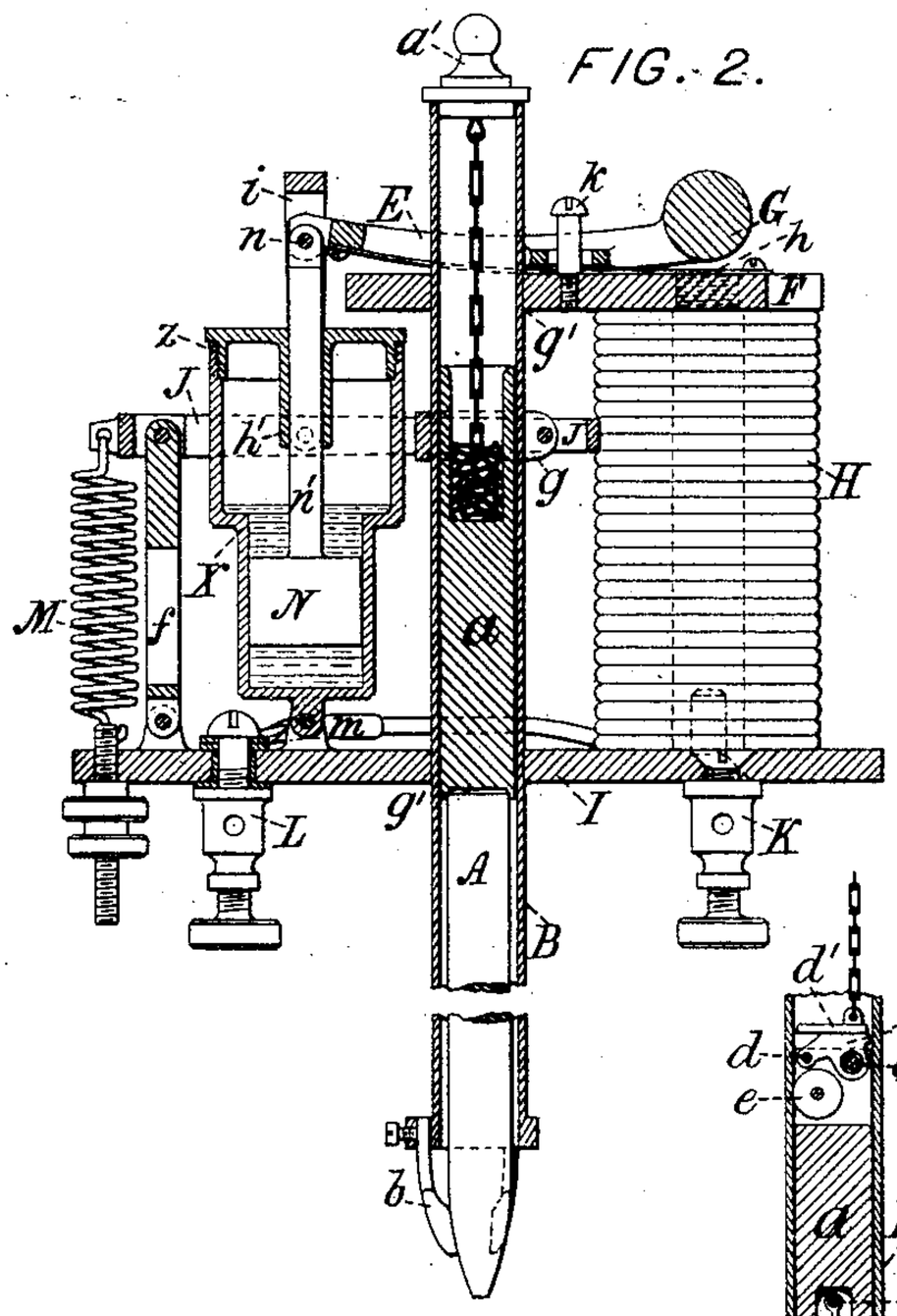


FIG. 4.

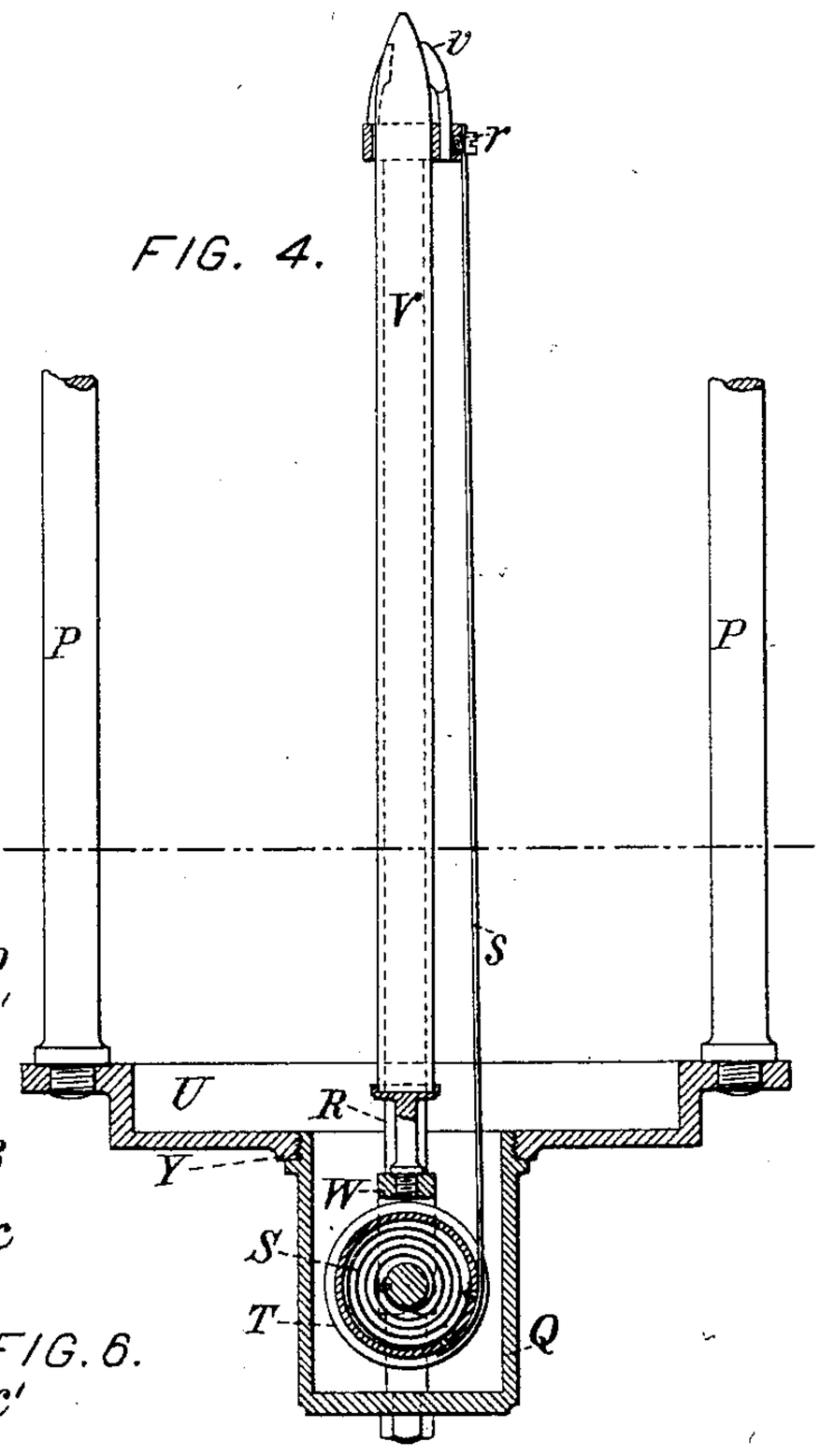


FIG. 3.

FIG. 6.

FIG. 5.

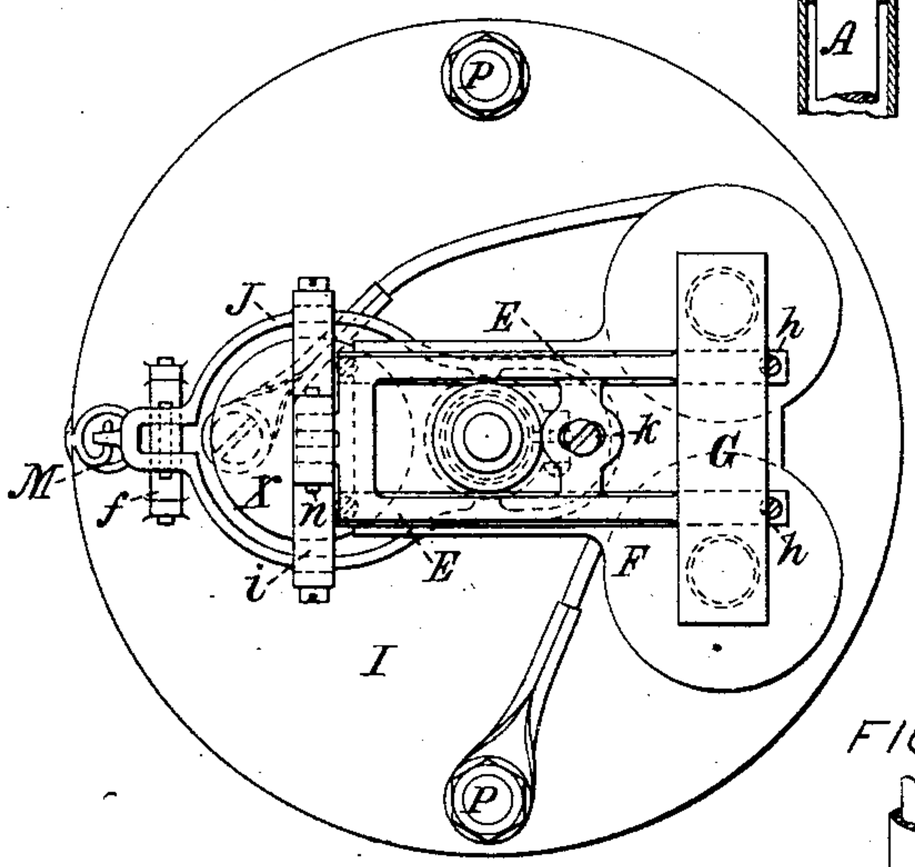
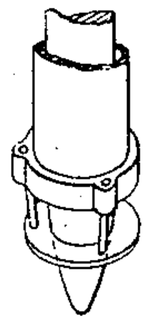
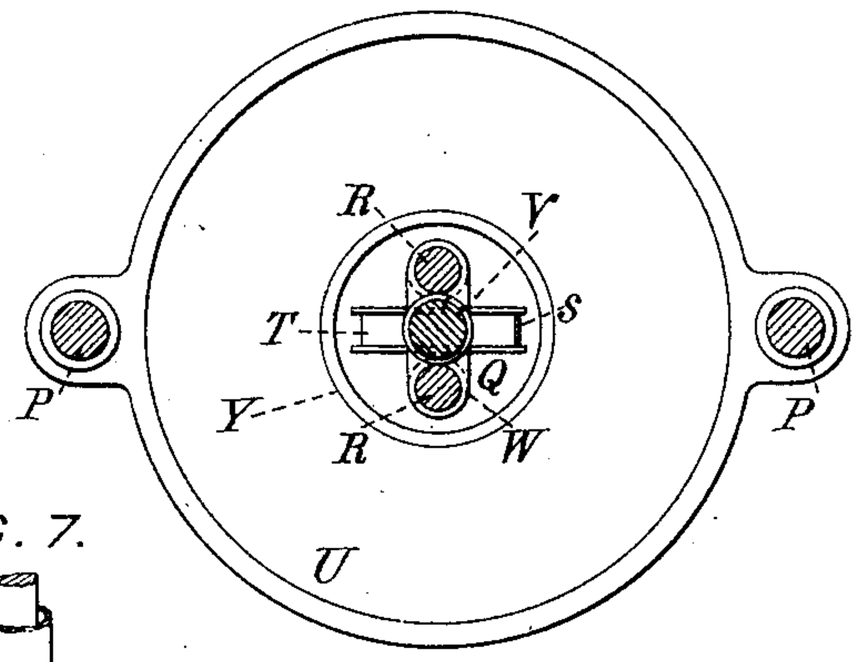


FIG. 7.





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UNITED STATES PATENT OFFICE.

GEORGE W. FULLER, OF NEW YORK, AND EDWARD D. MACKINTOSH, OF BROOKLYN, N. Y., ASSIGNORS TO THE FULLER ELECTRICAL COMPANY.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 229,246, dated June 29, 1880.

Application filed September 3, 1879.

To all whom it may concern:

Be it known that we, GEORGE W. FULLER, of the city of New York, in the county and State of New York, and EDWARD D. MACKINTOSH, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric Lamps, otherwise known as "Carbon-Regulators," of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, and to the letters of reference marked thereon.

In the drawings, Figure 1 is a perspective view of our electric lamp ready for use. Fig. 2 represents a vertical section of the upper part of our lamp. Fig. 3 represents a top plan of the same. Fig. 4 represents a vertical section of the lower part of our lamp. Fig. 5 represents a sectional plan of the lower part of our lamp from the dotted line on Fig. 4. Fig. 6 represents a vertical section of a modification of the weight *a*, shown in Fig. 2. Fig. 7 represents a substitute for the detaining-fingers *b* or *v*, shown in Figs. 1, 2, and 4.

Throughout the several views like parts are marked with the same letters of reference.

The object of our invention is to produce an apparatus which, while holding two pencils of carbon or other suitable material in the same axial line, shall keep the two adjacent ends thereof in contact when there is no electric current circulating through the pencils and the apparatus, but which, upon the circulation of a sufficient electric current, shall produce a proper separation of the pencils and maintain the same in one unvarying position during the entire period of their consumption in the arc, thereby producing what is commonly known as a "focusing electric lamp."

Referring now to the drawings, A represents the upper pencil, pointed at its lower end, and pressed downward by the action of the weight *a*, but retained within the tube B by any suitable number of detaining-fingers *b*, of platinum or other refractory and non-oxidizable metal, which are spread sufficiently to enable the greater portion of the conical end of the pencil to project beyond their tips. These detaining-fingers serve, also, to conduct the electric current to a point on the pencil near that at which the arc is produced, thereby offering to the electric current much less resistance than would be offered were it forced to traverse the entire length of the poorly-conducting pencil, as in most of the electric lamps now in use.

Some lamps use pencils plated with copper for the purpose of reducing this resistance; but such plating increases their cost, and the copper, when volatilized in the arc, causes the light to assume a disagreeable color.

When only one detaining-finger is used the pencil is pressed over to the opposite side of the tube, and better electrical connection results than from the use of a greater number; but three fingers retain the pencil more perfectly in line, and make a sufficiently good connection for ordinary currents.

For the detaining-fingers may be substituted a ring or washer of refractory and non-oxidizable metal, having a central hole slightly smaller than the body of the pencil. Such a ring or washer, (which we consider the equivalent of the detaining-fingers,) suspended from the tube B by three wires, is shown at Fig. 7 of the drawings.

By curving the wires in toward the center, they might act to detain the pencil, and the washer or ring serve only to tie them together and to protect them from the heat of the arc.

The weight *a* is connected to the removable cap *a'* by a chain, the slack of which is contained within the cup in the top of the weight *a*, and by means of which the weight may be removed when desired.

A somewhat more complicated but much more efficient arrangement of weight is shown at Fig. 6, in which *a* represents the weight, having attached to its bottom, by means of a loosely-fitting swivel-joint, *c*, the clamp *c'*, operated by a screw to grasp the pencil. With such an arrangement the stumps of the pencils are drawn out with the weight.

Working in a slot in the top of the weight *a* is a dog, D, pivoted at *d*, and kept in contact with the tube B by the action of gravity. This dog offers no resistance to the falling of the weight *a;* but when the electric current ceases to circulate, and the tube B falls, as hereinaf-

ter fully described, the pencil A comes into contact with and stops against the pencil V. The tube B would continue to fall, and the detaining-fingers *b* be separated from the pencil A, were it not that the dog D jams in the tube the instant the latter begins to fall away from the weight *a*. The friction-roll *e* takes the thrust of the dog D and causes it to release easily, when the weight *a* is again offered an opportunity to fall. The chain is in this case connected to the dog D, and the slack piles upon the table *d'*, which nearly fills the tube and is fixed to the dog. Upon pulling the chain from above, to raise the weight, the first effect is to raise the dog and separate it from the tube; but excessive movement of the dog is prevented by the pin *e'*, which is fixed to the weight, and which passes through a hole in the dog large enough to permit the proper movement.

At V is the lower carbon, pressed upward against the detaining-fingers *v*, similar to those described above, by the action of the carriage W sliding upon the rods R, and pressed upward by the action of the coiled spring S, one end of which is fastened to an arbor fixed to the carriage W and the other to the barrel T, tending to rotate the same upon the arbor running loosely through its center, and thereby wind upon the said barrel the ribbon *s*, secured to the cross-piece *r*, tying together the tops of the rods R R. A toothed rack might be substituted for the ribbon *s*, engaging with teeth cut upon the periphery of the barrel T. By a slight alteration in the arrangement of the carriage and barrel, one of the rods might, by having teeth cut upon it, serve also as the rack. Such an arrangement of toothed barrel and rack we consider the equivalent of barrel and ribbon.

The shapes which the points of the pencils assume during their consumption vary with their quality and with the strength of the current, and although they never vary greatly from the shapes shown, they are sometimes more and sometimes less acute. Such variations in the shape cause variation in the lengths of pencil extending beyond the fingers. To compensate for this variation and thereby maintain a proper length of arc, as well as to produce the initial separation, we employ a rocking lever, E, resting upon the table F, and provided with an enlargement at G, acting as an armature to the electro-magnet H, the cores of which are connected to the iron plate I and extend through and support the table F. The other end of the rocking lever E is connected, by the bail-shaped link *i*, to the lever J, having its fulcrum at the upper end of the oscillating standard *f*, which is pinned at its lower end to ears upon the plate I.

The lever J is connected, by pivots at *f'*, to the clamp *g*, secured by a clamp-screw, as shown in Figs. 2 and 3, upon the tube B, which fits loosely in the bearings *g' g'*, and which admits of a vertical reciprocating movement. With this arrangement it will be readily understood that as the armature approaches the electro-magnet the tube, its pencil, and its attachments will be caused to rise and to recede from the lower pencil, V. With the reverse motion of the armature the tube B, with its pencil and attachments, will be caused to descend and to approach the lower pencil, V.

Theoretically the curve of the rocking lever should be such that although the attractive influence of the electro-magnet upon the armature increases rapidly as the distance between them decreases, with the proper constant current circulating through the magnet-coils, the weight of the tube B, with its pencil and its attachments, acting through the above-described arrangement of lever and link upon the one end of the rocking lever, would balance the attractive force of the electro-magnet acting upon the armature at the other end, irrespective of the position of the point of contact of the rocking lever with the table F, and therefore of the distance of the armature from the electro-magnet—that is to say, the rocking lever should manifest no tendency to rock from any one point to any other so long as the proper constant electric current circulates through the magnet-coils, but should balance at all points. In practice, however, it is not found necessary to perfectly balance the opposing forces, although the more nearly they approach to a perfect balance the more uniform will be the length of the arc produced.

When it is desired to operate our lamp the negative wire from an electric generator is connected to the binding-post L, electrically insulated from the plate I, and the positive wire to the binding-post K, from which the current passes, through the plate I and the tube B and its detaining-fingers, to the upper pencil; thence to the lower pencil, from which it passes, through the detaining-fingers *v*, the rods R, cup Q, and plate U, to the hangers P, electrically insulated from the plate I; thence to and through the helices of the electro-magnet to the binding-post L, from which it passes back to the generator on the negative wire. Until this circuit is completed the weight of the tube B, its pencil, and its attachments will cause the pencils to remain in contact; but as soon as an electric current sufficient to produce a light has circulated through the helices of the electro-magnet the latter will become excited, the armature drawn down, and the pencils caused to separate sufficiently to produce the electric arc. The arc produced will be of such a length as will interpose a resistance in the circuit just sufficient to reduce the electric current flowing to a quantity equal to that for which the curve of the rocking lever was constructed, for if the quantity were more the electro-magnet would be so strong as to further draw down the armature, and the armature would continue to be drawn down, and therefore the separation of the pencils continue to increase, until the electric current had been reduced by the resistance of the increased length of arc to a quantity equal to that for

which the curve had been constructed; while if, on the contrary, the current should be less than that for which the curve was constructed, the electro-magnet would be so weak that the armature would be permitted to rise and the separation of the pencils to decrease until, by the decreased resistance of the shortened arc, the electric current had been increased to the proper standard. Should the current from any cause cease to flow, the armature is released, and the tube B, with its pencil and its attachments, falls, from the action of gravity, until the two pencils come into contact ready for a new separation, when the current begins to flow.

It will be seen that our lamp, by varying the length of the arc, and thereby the resistance, becomes virtually a current-governor within certain limits.

After our rocking lever has been curved to suit a given generator it would with a more powerful generator produce too long, and with a weaker generator too short, a separation of the pencils.

To readjust our lamp to suit a more or less powerful generator, or, in other words, to adapt it to a new standard current, it is only necessary to increase or decrease the weight of the tube B and its attachments until an arc of the desired length is formed, which will then remain as uniform as if the rocking lever had been originally curved for such standard. For this purpose loose weights fitting the outside of the tube B might be provided. To conveniently provide for slight variations the spring M may be employed; but, on account of the uniformity of their action, weights are preferable even for slight variations.

To retain the rocking lever and armature in proper position on the table F we employ the light flat springs *h h*, attached at one end to the lever E and at the other end to the table F. These springs so arranged constitute an almost frictionless device sufficient to retain the parts in position during the operation of the lamp, while the screw *k* within the slot in the rocking lever, but so arranged as ordinarily not to touch the sides of the slot, prevents the lever and armature from being displaced sufficiently to injure any of the parts when subjected to more violent treatment than the springs could withstand. Sudden and violent changes in the position of the upper pencil and the tube B are prevented by the resistance which the glycerine or other suitable liquid contained within the cylinder X offers to the quick movement of the loosely-fitting piston N, connected, by means of its rod *n'* and the pin at *n*, to the rocking lever and the bail-shaped link *i*. The cylinder X, which is connected to ears upon the plate I by a pin at *m*, is enlarged above the part traversed by the piston to produce a reservoir sufficiently large to prevent the liquid from rising above the end of the neck *h'* on the cylinder-cover, and thereby escaping during handling or transportation when the lamp may be in a horizontal or an inverted position.

As the neck-extension on the cover of the cylinder X, when applied in electric lamps, is the invention of N. S. Keith, we distinctly disclaim the same.

Having described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In an electric lamp or light regulator, in combination with an electro-magnet, an armature attached to or forming a part of a curved automatic fulcrum-adjusting lever, so constructed that its bearing-surface shall rest and rock upon a supporting-table, the whole being so arranged as to automatically govern or regulate the current of electricity by varying the electrical resistance at the light-arc, substantially as and for the purpose herein specified.

2. In an electric lamp or light regulator, the combination of an electro-magnet, an armature connected with or forming a part of a curved automatic fulcrum-adjusting lever with curved portion resting and rocking upon a supporting-table, and a reciprocating pencil-carrier, when arranged and operated substantially as and for the purposes shown and described.

3. In an electric lamp or light regulator, the combination of an electro-magnet, an armature connected to or forming a part of a curved automatic fulcrum-adjusting lever resting and rocking on its curved portion on a supporting-table, and a reciprocating pencil-carrier provided with detaining-fingers or their equivalent, when arranged and operated substantially as described and shown, and for the purposes specified.

4. In an electric lamp or light regulator, in combination with an electro-magnet and an armature connected with or forming a part of a curved automatic fulcrum-adjusting lever, with curved portion resting and rocking on a supporting-table, a cylinder, X, and piston N, for the purpose of preventing sudden changes in the position of the parts.

5. In an electric lamp or light regulator, the combination of an electro-magnet, an armature attached to or forming a part of a curved automatic fulcrum-adjusting lever, a cylinder, piston, and a reciprocating pencil-carrier provided with detaining-fingers, or their equivalents, with metallic connections, when arranged and operated substantially as described, and for the purposes specified.

6. In combination with a reciprocating pencil-carrier, a weight, *a*, provided with a do D, arranged and operated in the manner described, and for the purposes specified.

7. The springs *h h*, when used to connect the rocking lever E to the table F.

8. In an electric lamp or light regulator, the combination of the barrel T with the spring S, one end of which is attached to the inside of said barrel and the other end attached to the arbor around which said barrel revolves

when operating to elevate the movable carriage W along the rods R, thereby raising the carbon V as it is consumed at the arc.

9. In an electric lamp or light regulator, the combination of the barrel T, containing the spring S, with one end attached to the inside of said barrel and the other end made fast to the arbor around which said barrel revolves, with the movable carriage W, sliding on the rods R, and the metallic ribbon or chain *s*, all arranged as shown and specified, when operated for the purpose of keeping the carbon V pressed against the detaining-fingers *v*.

10. In an electric lamp or light regulator, the combination of the barrel T, with the spring S, attached to the inside of said barrel and its arbor, around which it revolves, with the rods R, the movable carriage W, ribbon *s*, carbon V, cap-piece *r*, and detaining-fingers *v*, when operated for the purpose of keeping the upper part of the said carbon in a fixed position at the light-arc during combustion, substantially as shown and described.

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EDWARD D. MACKINTOSH.

Witnesses:
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