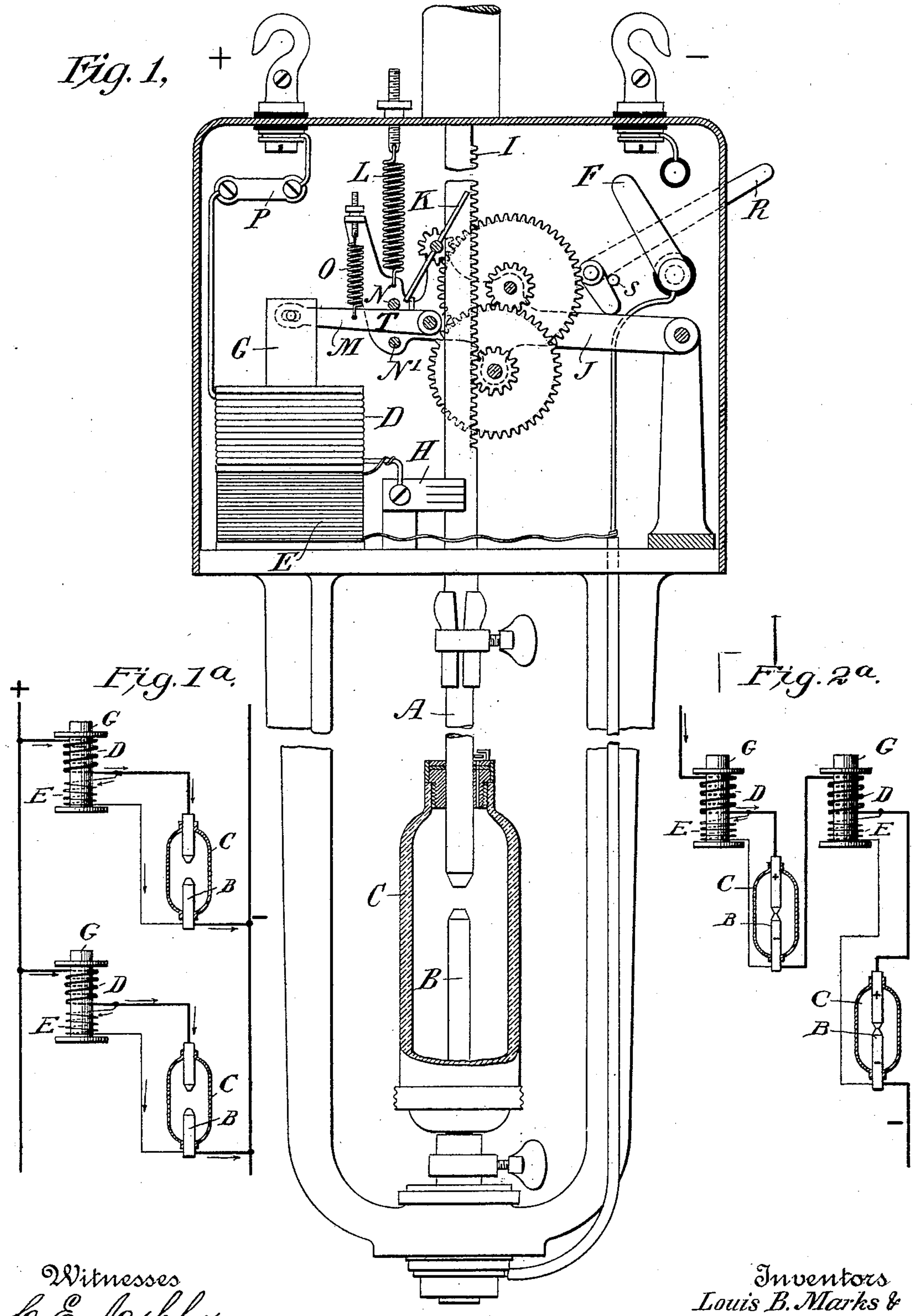
(No Model.) 2 Sheets—Sheet 1.

L. B. MARKS & C. RANSOM.

ELECTRIC ARC LAMP.

No. 520,996. Patented June 5, 1894.



Witnesses
C. E. Ashley
John P. Murphy

Inventors
Louis B. Marks &
Clarence Ransom
By their Attorneys
Pyrsleator hopes

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

(No Model.)

2 Sheets—Sheet 2.

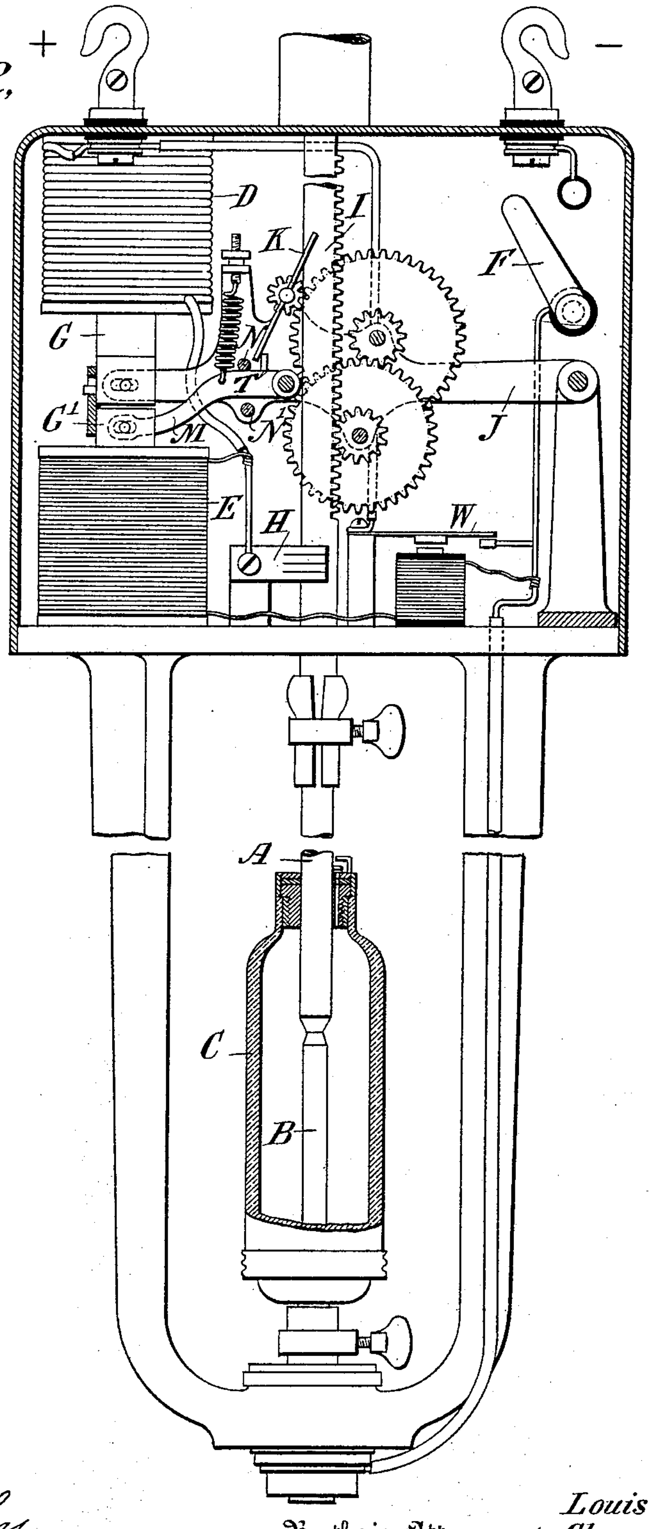
L. B. MARKS & C. RANSOM.

ELECTRIC ARC LAMP.

No. 520,996.

Patented June 5, 1894.

Fig. 2,



Witnesses

C. E. Ashley

John T. Murphy

Inventors

Louis B. Marks &

Clarence Ransom

By their Attorneys

Pipe Keeler & Rogers

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

LOUIS B. MARKS, OF NEW YORK, N. Y., AND CLARENCE RANSOM, OF PASSAIC, NEW JERSEY.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 520,996, dated June 5, 1894.

Application filed January 9, 1894. Serial No. 496,244. (No model.)

To all whom it may concern:

Be it known that we, LOUIS B. MARKS, residing in the city, county, and State of New York, and CLARENCE RANSOM, residing in Passaic, in the county of Passaic and State of New Jersey, citizens of the United States, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates to electric lighting. It involves a new method of operation by which an arc capable of producing an unusually great drop of potential without requiring an excessive flow of current for its maintenance may be produced. In operating arc lamps on circuits of constant potential, such as are ordinarily used for incandescent lighting it has been found impracticable to place a single arc lamp across the constant potential mains. The voltage ordinarily employed on such mains is one hundred and ten volts and in arc lamps as heretofore constructed the maximum drop of potential across the arc is about fifty volts or less; as ordinarily operated it has been found inefficient to adopt a higher voltage. A longer arc, and one having a materially greater drop, can not be maintained, the arc rupturing at a point between sixty and eighty volts, depending on conditions. By passing a very heavy current, that is to say, one of great ampèrage across the arc, a greater drop might be maintained, but a lamp so operating would be so inefficient as to be uncommercial. The lamp increases in efficiency as the current strength decreases, for the reason that the energy consumed varies as the product of current and electro-motive-force. In order, therefore, to reduce the flow of current, it has been found necessary to place in series relation to the lamp across the constant potential mains a resistance device by which a drop of potential may be produced, sufficient, when added to the drop produced in the arc between the electrodes, to reduce the current flow through the lamp to from eight to fourteen ampères. But the interposition of idle resistance for the purpose of cutting down current strength is an expedient which is wasteful of energy, inasmuch as a considerable proportion of the energy is converted into heat not useful to the operation of the lamp. It has been proposed to place two arcs in series relation across the mains of a constant potential circuit having a voltage of about one hundred and ten. In such a plan the amount of resistance employed may be reduced, but it is found in practice that two arc lamps so arranged do not work well, for the reason that the variation in the length of one arc alternately cuts down or increases the potential difference between the electrodes of the other lamp, and thus one or the other lamp is continuously robbing its mate of current, this so-called "see-sawing" action producing a fluctuation of the light.

Our invention is designed to admit of operating an arc lamp placed directly across a pair of constant potential mains, at the voltages ordinarily employed, without the interposition of idle resistance, and without wasting energy by permitting a current of great ampèrage to flow through the lamp. We accomplish this result by establishing between the electrodes of the lamp, that is to say, in the arc, a drop of potential sufficient to admit of a small flow of current, and by providing means by which such an arc may be continuously maintained so as to insure the operation of the lamp.

Our invention is applicable also to constant current circuits, that is to say, circuits in which a number of arc lamps are placed in series relation, and where the voltage varies in accordance with the demands of the several lamps, the current being of uniform strength. The advantage of employing a lamp capable of maintaining a high drop of potential across its electrodes in such circuits is that a current of small ampèrage and higher tension may be employed whatever be the number of arcs burning on the circuit. By employing an arc which creates a large drop of potential the aggregate potential required to maintain the circuit operative is greatly increased and conducting wires having a smaller cross-section may be employed, which of course involves a smaller expenditure for copper. In constant current lamps as ordinarily operated the drop across the arc is about forty-five volts, thus requiring for a circuit containing ten lamps, an aggregate po-

tential of more than four hundred and fifty volts. In lamps operated according to our invention, however, an arc capable of producing a drop of one hundred volts may be maintained easily, which, in a system similar to the above, would produce an aggregate of one thousand volts. It is evident that smaller conductors might be used in the latter system to convey the same amount of energy as that carried by the former.

Our invention is applicable also to alternating current circuits.

In carrying out our invention we surround the arc with a transparent or translucent inclosing medium, and provide means by which the electrodes may be separated a sufficient distance to produce an exceptionally great drop of voltage across the arc. We have found that when an arc is inclosed, preferably in a small inclosing envelope, that the electrodes may be separated to a much greater distance than is common in arc lamps, without danger of rupture of the arc, and that a current of but small ampèrage is necessary to maintain the arc. To spring the arc and effect its regulation, we have provided novel means, but our improvements may be carried out with fair success in systems equipped with arc lamps having regulating apparatus of ordinary construction, provided the arc be surrounded with a suitable inclosure and the regulating mechanism be adapted to spring a long arc.

Our invention therefore comprises a method of operating an arc lamp or arc lamps by confining the arc within an inclosure and maintaining it of a length to produce a great drop of potential in the arc without permitting excessive flow of current.

It also comprises a method of operating arc lamps on a circuit of constant potential by which practically all of the drop of potential in the lamp exists in the arc.

It involves also other features which will be more particularly hereinafter described, and which will be definitely indicated in the claims appended to this specification.

In the accompanying drawings, which illustrate the invention, Figure 1 is a side elevation, the housing for the regulating mechanism being shown in section, and part of the inclosing envelope for the arc being shown in section, of an arc lamp adapted to carry out our invention on a circuit of constant potential, and Fig. 2 is a similar view of a lamp adapted for circuits carrying constant current. Figs. 1^a and 2^a show diagrammatically a constant potential and a constant current system equipped with lamps.

Referring first to Fig. 1, A and B represent the positive and negative electrodes normally held apart, as indicated in the drawings, being surrounded in the neighborhood of the arc with an inclosure C of transparent or translucent material, preferably glass. The type of inclosure we prefer to use is such as is described in Letters Patent to Louis E. Howard, issued August 15, 1893, No. 503,539, in which the inclosure is of small diameter and is so constructed as to permit of the free feeding of the positive carbon without permitting material ingress of air to the arc. Our invention is not, however, restricted to such a construction. So long as the arc is within an inclosure which retards the escape of the gases and prevents atmospheric interference with the arc, good results may be attained. The best results are attained when the inclosure is so arranged that the air is totally excluded or has difficult access to the arc, though more or less good results are possible without the total exclusion of air, since the result depends upon the amount of oxygen reaching the arc. The difference between an arc so circumstanced, and one which is exposed to the open air, or in such a way that the air has unobstructed access to it, is very marked. Such an organization prevents a rupture of conductivity of the arc when of comparatively high resistance, say one hundred volts, and upward, even with a current as weak as three and one-half ampères, a result absolutely impossible with an open air arc. The regulating mechanism is provided with two controlling coils D, E, coil D being in series relation to the arc, and being formed of coarse wire so as to create a very slight drop of potential, and coil E being formed of fine wire. The latter is preferably placed in series relation with the former, and, with it, forms a continuous connection across the mains when the lamp switch F is closed. The drop in the coil D is made so low that the suction exerted upon a core G by the coil E is practically constant. Connected with the terminal of the coil D is a brush H which bears upon the carrier for the positive carbon. Said carrier is connected to or provided with a rack I co-operating with a train of wheel-work mounted upon a pivoted lever J, the last wheel of the train being provided with a fly K or other agent for slowing down the movement of the wheel train when the fly is released. The lever J is supported at its free end by a spring L, the tension of which may be regulated by an adjusting device, as shown. An auxiliary lever M is journaled upon the lever J and is pivotally attached at its free end to core G. Limiting stops N, N′ are provided at the sides of the lever M, and a controlling spring O, provided with a regulating screw for varying the tension, is connected to said lever. The rack I upon the carbon holder or carrier is made of such a length that when the positive carbon A is consumed to a short stub, the carrier will drop, and producing a short circuit through the carbons, a fuse P will be blown and the lamp cut out, or any other suitable means for cutting out the lamp may be adopted. A lever R is provided with a projecting arm, limiting the upward movement of lever J, and thus regulating the maximum length of the arc. The core G, when the lamps are designed to operate on alter-

nating current circuits, will preferably be laminated in a way well understood. The stop S for the lever R will be set in a position to permit an arc of a length suitable for the circuit upon which the lamp is to be used. On a one hundred and ten volt circuit the total resistance of the lamp from terminal to terminal may, with advantage, be made thirty ohms, thus permitting about three and two-thirds ampères to flow through the lamp with a consumption of one hundred and ten multiplied by three and two-thirds, or about four hundred watts, as contradistinguished from one hundred and ten multiplied by ten or eleven hundred watts in a good form of lamp provided with an auxiliary resistance, as above referred to.

The operation of the lamp will be as follows: The carbons are normally held apart by the retractile spring L, the fly K being arrested by a projection T upon lever M. When the switch is turned, current flows through coils D and E in series relation to the negative main. The carbons being held apart, a very small current flows and the series coil exerts but little suction upon the core G. The shunt coil acts practically unimpeded to draw down the core and to bring the carbons into contact. When the carbons touch, a heavier current flows through the series coil by way of brush H and the carbons to the negative main. The coils D, E being differentially wound, the former opposes the effort of the latter, and the spring L lifts the positive carbon A. As the positive carbon is consumed the series coil weakens in effect and the shunt coil overcomes the combined effort of the series coil and spring O, depressing lever M and releasing the fly K, the weight of the carbon and carrier then producing a downward feed, during which the series coil increases its pull and co-operates with the spring O to lift the stop T and arrest the feed. In trimming the lamp the carbons are brought into contact while the lever R is depressed, and the latter is then elevated, the spring L lifting the upper carbon. We prefer to connect the two regulating coils in series and lead the arc branch from the point of junction, as by such a construction the feed is rendered more sensitive. An advantage of considerable importance arises from the fact that the shunt coil is in series relation to the series coil. The variation in resistance of the arc during its regulation produces a variation in the drop of potential in the series coil, so that when the drop is decreased in the series coil an increased difference of potential will exist at the terminals of the shunt coil, and thereby produce a slightly increased effect on the shunt coil with reference to the series coil; moreover, it will be seen that in this method of regulation the slightest change in the potential difference between the terminals of the series coil will cause a comparatively large change of current in said coil, so that by properly designing the coils a very sensitive regulation can be effected. If the shunt coil were directly across the mains the drop would be constant and independent of fluctuation in the arc and the regulating action would not be so sensitive.

In Fig. 2 we have shown a modified form of lamp that is well adapted for constant current circuits. As it is desirable in this type of lamp that the branch through the carbons shall be normally completed, the retractile spring L of the type shown in Fig. 1 is omitted, and the carbon holder is permitted to drop by gravity. As in Fig. 1, the train of wheel-work is supported upon a frame carried by a pivoted lever J, and the fly is normally locked against movement. When the switch is closed, which will be its normal position, current will flow from the positive terminal through the coil D to brush H, and thence to the carbon rod and through the carbons to the negative main. A portion of the current will flow over a derived branch including the shunt coil E. The lever J is hinged to a core G governed by the series coil, and lever M, which carries the detent T, is connected with a separate core G′ controlled by the shunt coil. When the circuit is closed, therefore, the carbons are lifted apart by coil D and the arc sprung. A variation of current through the arc sends more current through coil E, thus withdrawing the stop T from the path of the fly and permitting the wheel-train to move and the positive carbon to descend. When the arc increases to such a length that the lamp will not continue to burn, an excess of current passing through the shunt coil will actuate a cut-out W in the usual manner. When employed on alternating circuits the cores G, G′ should be laminated. A lamp constructed as herein described will maintain an arc producing a drop of one hundred volts or more with a current of less than three and one-half ampères.

We prefer to use pure carbon electrodes, so that the arc will be formed of incandescent, vaporous or gaseous products of carbon, but we may in some cases use electrodes of other kinds.

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

1. The method of operating an arc lamp on constant potential circuits which consists in confining the arc within an inclosure, restricting practically all the drop of potential in the arc circuit to the arc and continuously maintaining said drop at a point which prevents an excessive flow of current.

2. The method of operating an arc lamp consisting in confining the arc within an inclosure from which the air is excluded or to which it has difficult access and maintaining a long arc to produce a larger than normal drop of potential, whereby an arc light of normal intensity may be maintained by an ampèrage lower than normal.

3. An arc lamp provided with a retractile spring tending to normally separate the carbons, a coil connected to the lamp terminals

to bring the carbons together when current is admitted to the lamps, and an auxiliary coil in the arc branch for regulating the length of the arc the two coils being in series relation.

4. An arc lamp provided with a retractile spring tending to normally separate the carbons, a shunt coil connected to the lamp terminals to bring the carbons together, and a series coil in the arc branch differentially wound with relation to the shunt coil, both coils being in series relation acting upon the regulating mechanism through the instrumentality of the same core.

5. An arc lamp for constant potential circuits provided with a spring normally holding the electrodes apart two regulating coils differentially acting on said spring, said coil being in series relation to each other and to the supply current, one being in series with and the other in a shunt around the arc.

In testimony whereof we have hereunto subscribed our names, at New York, N. Y., December 26, 1893.

LOUIS B. MARKS.
CLARENCE RANSOM.

Witnesses:
LAVINIA JACKSON,
H. BECKER.