(No Model.) 3 Sheets—Sheet 1.

J. F. KELLY.

ELECTRIC ARC LAMP.

No. 303,020. Patented Aug. 5, 1884.

Fig. 1.

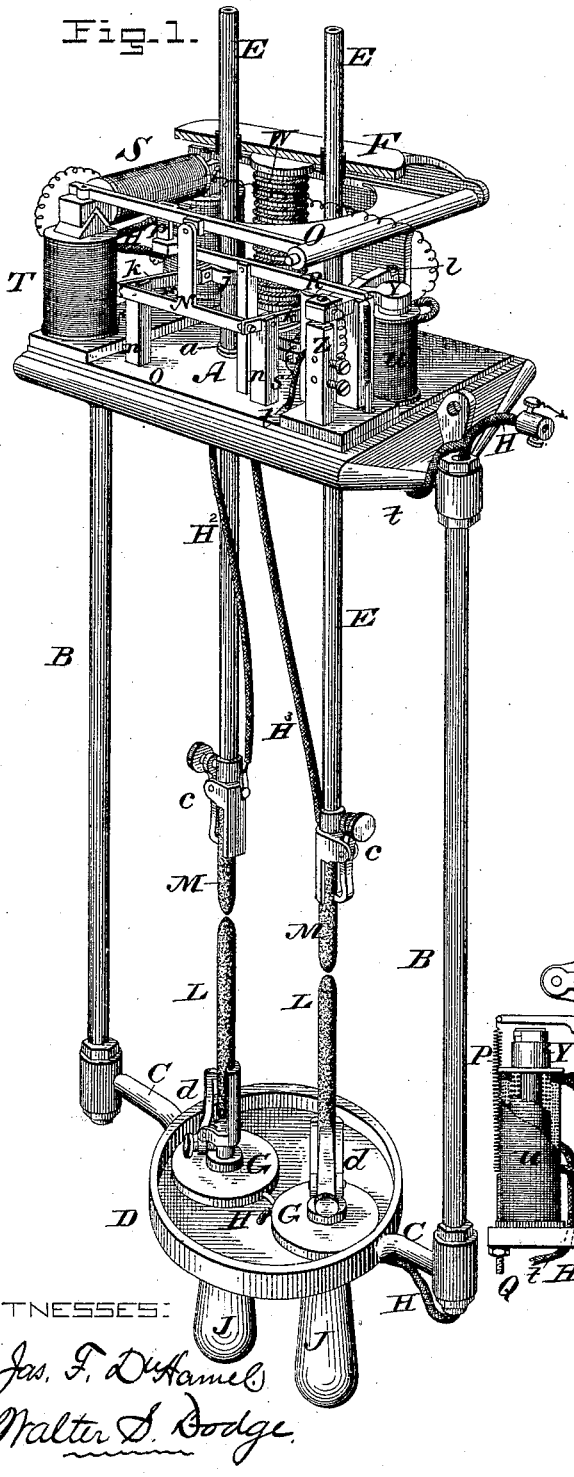


Fig. 2

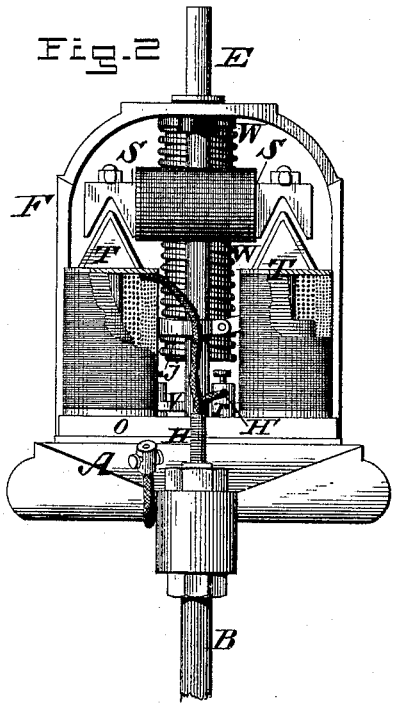
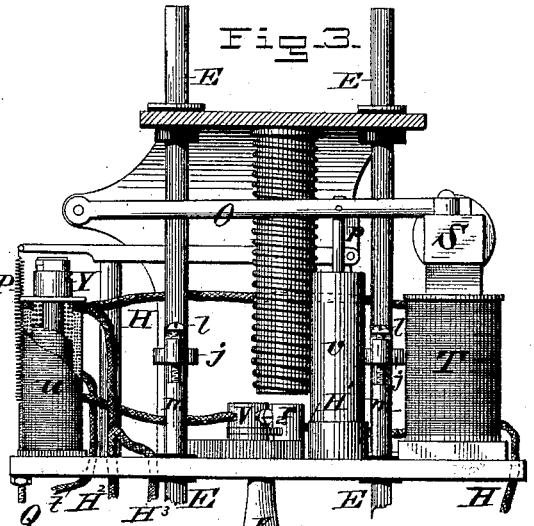


Fig. 3.



WITNESSES:

Jas. F. DeHamel

Walter S. Dodge

INVENTOR:

John F. Kelly,

by Dodgeson,

Attys.

(No Model.) 3 Sheets—Sheet 2.

J. F. KELLY.

ELECTRIC ARC LAMP.

No. 303,020. Patented Aug. 5, 1884.

Fig. 4.

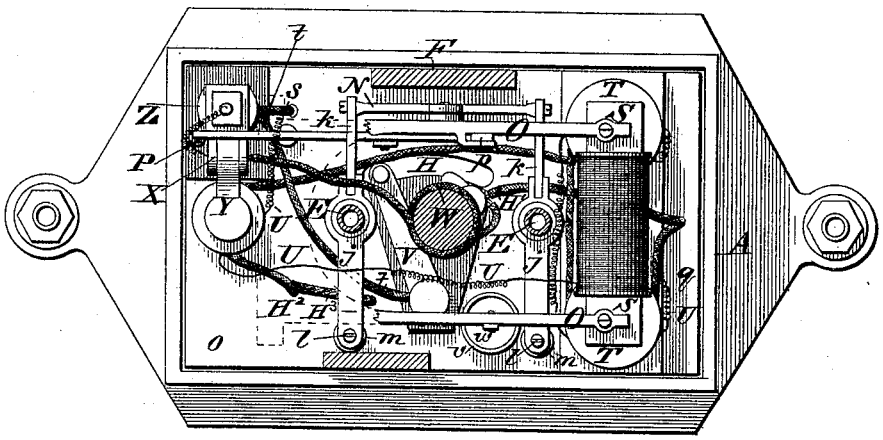


Fig. 5.

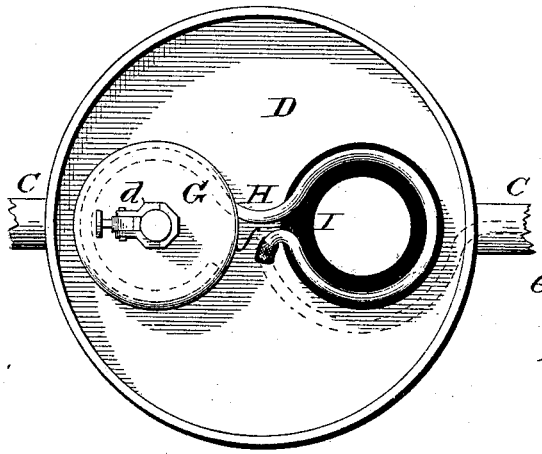
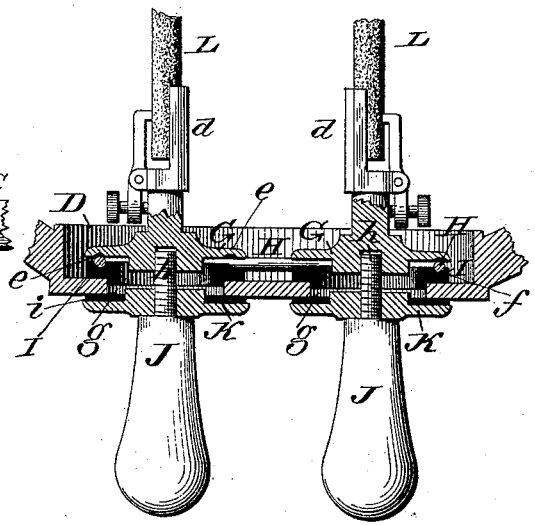


Fig. 6.



WITNESSES:

Jas. F. DeHaven.
Walter S. Dodge.

INVENTOR:

John F. Kelly,
by Dodger & Son,
Attys.

(No Model.) 3 Sheets—Sheet 3.

J. F. KELLY.

ELECTRIC ARC LAMP.

No. 303,020. Patented Aug. 5, 1884.

Fig. 7.

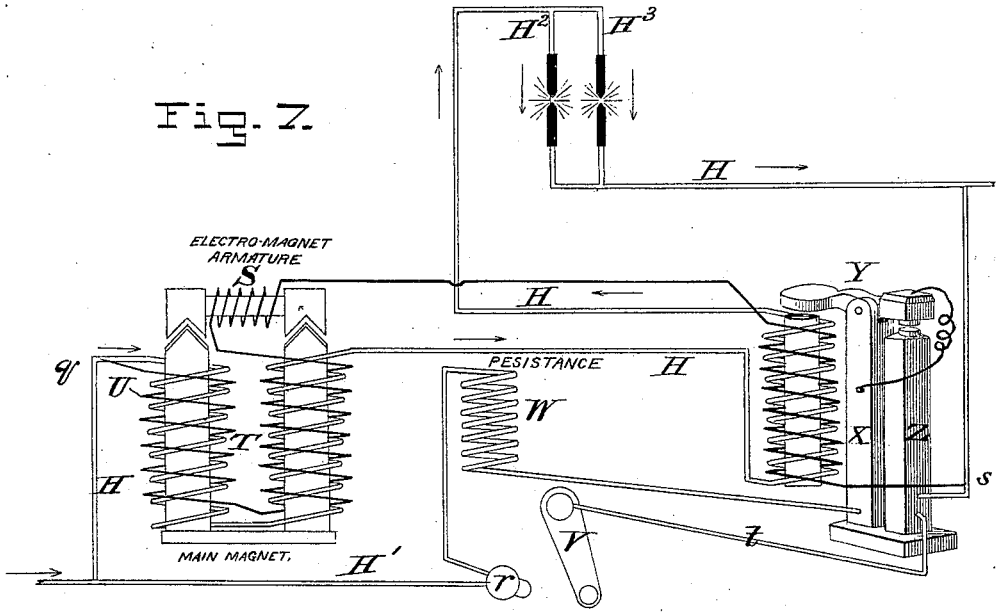
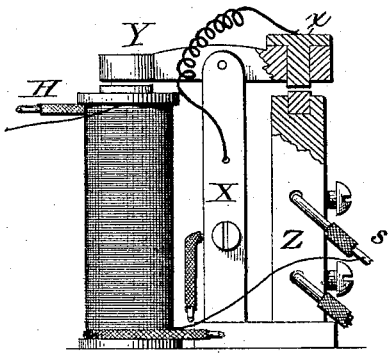


Fig. 8.



WITNESSES:

Jas. F. O'Hamel.

Walter S. Dodge.

INVENTOR:

John F. Kelly
by Dodgerson
Attys.

UNITED STATES PATENT OFFICE.

JOHN F. KELLY, OF LITTLE FALLS, NEW YORK, ASSIGNOR TO THE PARKER ELECTRIC MANUFACTURING COMPANY, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 303,020, dated August 5, 1884.

Application filed October 1, 1883. (No model.)

To all whom it may concern:

Be it known that I, JOHN F. KELLY, of Little Falls, in the county of Herkimer and State of New York, have invented certain Improvements in Electric Lamps, of which the following is a specification.

My invention relates to that class of electric-arc lamps in which the differential action of electro-magnets in the main and in a derived circuit serves to separate and control the carbons, and particularly to such as have said magnets opposed and one arranged to serve as an armature for and move relatively to the other.

The improvements consist in a novel construction and arrangement of parts, hereinafter fully pointed out, by which I am enabled to secure great delicacy and certainty of action, together with perfect safety, under all circumstances, both to the lamp and to its surroundings.

Figure 1 represents a perspective view of a double-carbon lamp constructed in accordance with my invention, the upper housing of the mechanism being partially broken away to expose the parts; Fig. 2, an end view from the left-hand of Fig. 1; Fig. 3, a side elevation of the mechanism from the rear of Fig. 1; Fig. 4, a plan or diagram showing the magnets, carbon rods, clamps, and attendant parts, and illustrating the circuits and connections; Figs. 5 and 6, views illustrating the manner of holding and making electrical connection with the lower carbons; Fig. 7, a diagrammatic view showing the directions of the circuits, and Fig. 8 a detail view of the cut-out.

I may here remark that I do not make any claim to the broad idea of differential magnets as applied to the control of carbons in electric lamps, as that has been known for many years, having been first fully explained and illustrated, as I believe, by Lacassagne and Thiers in 1856; nor do I broadly claim opposing the main and derived circuit magnets and causing one to act upon and move the other according to the differential action of the magnets, for that has been known since June, 1878, such a lamp having been constructed and fully described and illustrated as early as said date by Tchikoleff. My claims therefore relate to the novel construction and arrangement of parts, as will now be explained.

In its general appearance this lamp is not unlike others of various makes in common use—that is to say, it embraces a frame consisting of a top plate or platform, A, upon which are mounted the electro-magnets, clamps, cut-out, and attendant parts, two side rods, B, preferably of tubular form, and a cross-bar, C, advisably widened into or furnished with a platform or bed, D, to support the lower-carbon holders, the lamp here shown having two sets or pairs of carbons. The top plate or platform, A, is preferably made of metal, and is perforated to permit one or more carbon-carrying rods, E, to pass through, the holes *a* being bushed with gutta-percha or other good insulator when said platform is thus made of metal.

The mechanism of the lamp is placed within a housing, F, preferably cast in one piece with a base or bed plate, *o*, and screwed or bolted upon platform A in such manner that it may be detached and bodily removed from the frame without difficulty, the top of said housing being also perforated, and having such perforations or holes bushed, in the same manner as the holes *a*, to prevent the escape of electricity into the frame from the rods E, which pass through them.

The rods E carry the upper carbons, as is usual in this class of lamps, being furnished with clamps *c*, by which the carbons may be firmly held. The lower carbons are held by similar clamps, *d*, extending upward from metallic disks G, which are each formed with a shallow annular groove, *e*, in the under side to receive or fit over the wire H, which forms a part of the light-circuit, said wire passing up through the platform or bed D and following around the groove of one disk G, then crossing to the second disk and following its groove in the same manner. The lower side of the wire is seated in similar shallow grooves, *f*, formed in the upper faces of insulating-rings I, of gutta-percha or other suitable material, resting upon the bed or platform D and encircling openings *g* therein. The disks G are clamped upon the wire H, and with said wire and the insulating-rings are held in place by screw-stems *h*, provided with handles J, and passing centrally through disks or washers K, beneath the platform, of sufficient diameter to overlap the openings *g*, as shown in Figs. 5 and 6, the disks K having facings *i*, of gutta-percha or equivalent insulating material, to prevent metallic contact with the frame.

The openings *g* are of sufficient size to permit the disks G K to be moved laterally in any direction to a considerable extent without bringing the screw-stems *h* into contact with the sides of the openings, so that the lower carbons, L, may be accurately brought into alignment with the upper carbons, M. The current is carried from the disks G by the wire H, which is properly insulated, except beneath said disks, upward through one of the tubular side bars of the frame back to the line.

The mechanism for controlling the upper carbons, which alone are fed forward as they burn away, will be now explained.

The carbon-carrying rods E are each encircled by a clamp or lifter consisting of a flat bar or strip, *j*, pivoted at one end to a short rocking lever, *k*, weighted at its opposite end, and provided at said weighted end with a set-screw, *l*, which comes into contact with a stop or fixed rest, *m*, as the clamp falls, stopping the descent of the weighted end before the other end ceases its movement. The lever *k* is pivoted in a post, *n*, formed upon the base-plate *o* of the housing F, and its rear end is jointed to a bar, N, of inverted-T form, which bar is suspended from or connected to a rocking frame, O, pivoted in the housing F, and free to rise and fall therein to a limited extent, it being understood that the levers *k* of both clamps are thus connected, one at each end of bar N. It will be seen that in consequence of the above arrangement a depression of the frame or rocking lever O, and consequent descent of the bar N, will cause the depression of the rear ends of the short levers *k*, elevating their opposite ends and raising the clamp bars or plates *j*, while the rise of the rocking frame O will reverse the above-stated action. To insure the rise of the frame or lever O when not held down by magnetic attraction, as presently explained, a spring, P, is provided, one end of which is attached to an adjusting-screw, Q, and the other end of which may be attached to a rearwardly-projecting arm on said frame; or, as is preferred, to the rear end of a pivoted lever, R, the forward end of which is connected by a link, *p*, with the rocking frame, as shown.

At its free or moving end the rocking frame O is furnished with an armature, S, which is carried across the poles of an electro-magnet, T, introduced into the main or arc circuit, and formed by coiling the circuit-wire H about the soft-iron cores, as indicated. The current, in passing through the coils, renders the cores strongly magnetic, and causes the attraction of the armature S, which, descending, carries down the frame O, and, acting through bar N and levers *k*, elevates the clamps *j*. The clamps previous to such elevation stand in a horizontal position, or with their outer ends slightly above their pivots, the outer ends being limited in their descent by the stop-screws *l*, as mentioned. As soon, however, as the frame O is drawn down, the clamps *j* are raised, the weight of their free ends causing said ends to stand still, or practically so, until the inner ends are raised sufficiently to cause the clamps to cramp and bind upon, and consequently lift, the carbon-carrying rods, effecting the necessary separation of the upper and lower carbons to produce the arc or arcs.

The incoming end of the line-wire H is divided into three branches, H′, H², and H³, the first of which connects with an insulated post, *r*, with which contact may be made by a hand-switch, V, in metallic connection with the outgoing end of the line-wire, to enable the lamp to be manually cut out of circuit, while the branches H² and H³ connect with the clamps *c* of the carbon rods E, and serve to carry the current thereto, being made of flexible woven wire or like material, to permit the rise and fall of the rods.

A branch circuit, U, of high resistance, is formed by connecting a fine wire with the main-circuit wire at *q*, close to the point at which said main wire enters the lamp, and carrying said fine wire across the lamp to the outgoing end of the main wire, to which it is connected at *s*, as shown, the intermediate portion being formed into coils or windings sufficient to produce the required resistance.

For the sake of convenience, and to secure also their neutralizing action upon its cores, I form such coils in part about the spools or coils of the electro-magnet T, and I carry the wire thence to and around the armature S, which is of soft iron, winding the wire in a direction to produce in the poles of the armature magnetism of the same sign as that in the opposing poles of the electro-magnet T. Owing, however, to the comparatively great resistance of the derived circuit, but a small portion of the current passes through it while the lamp is in its normal working condition and the arc of ordinary length, so that the magnetism of the armature will be slight at such time, and practically or totally neutralized by the inductive action of the stronger electro-magnet T. When the arc becomes elongated, a greater proportion of the current is thrown into the derived circuit, and the magnetism of the armature-core grows proportionately stronger, while that of the main magnet T is more or less neutralized by the current thrown into and passing through the fine-wire coils thereon, all tending to lessen the attractive power of magnet T, and to increase the repelling force of the electro-magnetic armature S, due to the opposition of like poles. Thus the frame O is released and permitted to be raised by the spring P whenever the arc grows so long as to require the carbons to be fed forward.

To prevent the effects of residual magnetism and the retention of the armature by the electro-magnet T after the latter is sufficiently weakened, as happens when the iron of the cores and armature is permitted to come into actual contact, I face the cores with copper or other thin non-magnetic material, as shown in Fig. 2.

To permit a considerable movement of the frame O without carrying the armature out of the field of the magnet T, I make the ends of the cores of said magnet of inverted-V shape, and I notch or recess the projecting ends of the armature to fit over said poles, so that the frame can move a considerable distance without greatly affecting the attractive power of the magnet upon the armature.

It is necessary, in order to render the lamp absolutely safe, that an automatic cut-out be provided to cut the lamp out of circuit, in case of the arc becoming so long as to endanger its surroundings—an event that is liable to occur through the sticking of the carbon rods E, the breaking of a carbon, or other cause; and it is also desirable that this cut-out should offer a path for the current to succeeding lamps of far lower resistance than the derived circuit, which, of course, is incapable of carrying the full current. Such special cut-out I form in the following manner:

W represents a German-silver wire or short coil, one end of which is connected with a metal post, X, in which is pivoted a rocking armature, Y, one end of which armature is placed directly over and slightly above a metallic binding-post, Z, as shown in Fig. 1, into which is inserted and clamped one end of a branch wire, *t*, connecting with the outgoing end of a short wire connecting the hand-switch V with said outgoing end of the circuit or line wire, as before mentioned. The opposite end of the German-silver wire or coil is secured in the post *r*, with which the hand-switch makes connection when the lamp is manually cut out, and which is in metallic connection with the incoming end of the main-circuit wire through the branch H′, as indicated.

The armature Y is weighted, so that when not otherwise acted upon its weighted end will drop and rest upon the end of the binding-post Z, placing the two posts X and Z in metallic connection, and establishing a short circuit from the incoming line-wire through branch H′, post *r*, German-silver coil W, post X, armature Y, post Z, and wire *s* to the outgoing end of the line-wire around the arc or lamp, thus permitting the current to pass by the lamp without passing through its carbons.

In order to avoid the magnetizing effect of passing the current through the iron body of armature Y, the latter is advisably furnished at its gravitating end with a non-magnetic plug, pin, or block, *x*, to bear upon post Z, and with which the German-silver wire W is connected by a short wire or metallic strip, as indicated. It is therefore to be understood that in speaking of making or completing the short circuit through the armature Y it is not meant that the current necessarily traverses the iron body of said armature, but that it preferably passes through a copper or brass plug carried by the gravitating end of the armature.

When the lamp is in proper working order, it is of course necessary that this shunt or short circuit should be interrupted or opened, as otherwise the current would leave the carbons and take such route; hence I provide beneath the rear end of the armature—that is to say, the lighter end, which is farthest away from post Z—an electro-magnet, *u*, formed of a soft-iron core encircled by a helix of the main-circuit wire, so that when the current is passing in considerable strength through the main or arc circuit, and consequently producing the arc between the carbons, which the current passes through before reaching electro-magnet *u*, the core will be rendered strongly magnetic, and will attract the armature Y, thereby raising its weighted end off of post Z and opening or breaking the short or cut-out circuit, preparatory to a separation of the carbons to form the arc. About the core of electro-magnet *u* is also wound a second coil of fine wire, being a continuation of wire U of the high-resistance derived circuit, in which also the magnet *u* is thus included. The fine wire is wound in a direction to produce in the core of magnet *u* a polarity the reverse of that due to its coarse helix of the main-circuit wire; hence if the current in said fine wire or derived circuit be considerably or greatly increased by reason of an abnormal increase in the length of the arc, and consequent diversion of a material portion of the current from the main into the derived circuit, the effect of the coarse-wire helix will be lessened or entirely neutralized, the magnet *u* will be practically or wholly demagnetized, and the armature Y will fall, making contact with post Z, and closing or completing the short circuit of the cut-out. This condition of things will continue and the current will be conveyed by the short circuit to succeeding lamps until the equilibrium of the lamp is again restored and the normal arc reproduced, whereupon the short circuit around the lamp will be again broken or opened, as explained.

It is of course to be understood that the neutralizing effect of the fine wire must not be sufficient to overcome the attractive force of the magnet *u*, except when the current through the carbons is wholly or almost entirely interrupted and there is danger of injury to the lamp. Such neutralization must not occur or become sufficient to release the armature Y upon such weakening of the main current or circuit as occurs at the instant of feeding the carbons, as in that case the lamp would be cut out whenever the carbons were fed forward. The relative windings of the two coils, the balancing or weighting of armature Y, and like means of regulating the release of the armature permit such release to be perfectly adjusted, regulated, and controlled.

The construction may be precisely the same for single-arc lamps as for the double lamp herein described, except that the carbon-carrying rod, clamps, holders, &c., need not be duplicated.

It is obvious that the cut-out circuit may be made by carrying the German-silver wire di-

rectly from the incoming end of the line across to post X, and that the German silver may be replaced by any other suitable conductor, though it is preferred because of about the proper conductivity.

From the foregoing it will be understood that when the lamp is in proper working order the current will pass through the carbons, leaping across and producing the arc between their slightly-separated ends, and that when the arc becomes abnormally long it will be short-circuited by the cut-out through the German-silver coil or wire.

The fine-wire coils upon the spools of electro-magnet T may be omitted, but if used should be wound in opposition to or differentially with the main or coarse-wire coils thereof.

The frame O directly actuates the mechanism for separating and feeding the carbons, and this frame has a simple motion up and down, carrying the electro-magnetic armature to and from the main electro-magnet at right angles to the line joining the poles of the said magnet.

The construction is simple, and the action of the lamp is very perfect, steady, and delicate.

The spring P is designed, mainly, to counterbalance the frame O and the parts directly connected therewith, the elevation of the frame being mainly or, it may be, entirely due to magnetic action, as explained. A weight may be substituted for the spring and made movable for adjustment, though the spring is deemed much the better agent. A dash-pot, *v*, the plunger or piston of which is carried by a rod attached to the rocking frame O, prevents the too sudden movement of the frame and attendant parts.

Having thus described my invention, what I claim is—

1. In an electric lamp, the combination of an armature carrying a coil included in a derived circuit about the arc and directly actuating the mechanism for separating and feeding the carbons, with an electro-magnet wound differentially, one coil being included in the main and the other in a derived circuit, said armature being capable of motion only in a line at right angles to the line joining the poles of said magnet.

2. In an electric lamp, the combination of an electro-magnet in the arc-circuit, a clamp or lifter adapted to raise the upper carbon, a rocking frame connected with said clamp, and an armature mounted upon the free end of the said rocking frame and wound with a coil included in a derived circuit of high resistance, substantially as shown and described.

3. The combination, in an electric lamp, of upper and lower carbons, a carrying-rod, E, for the upper carbon, a lifter, *j*, encircling said rod and pivoted to a lever, *k*, a rocking frame, O, provided with an elevating-spring, P, connected with the lever *k*, substantially as shown, and provided with an armature having its coil included in a derived circuit around the arc, and an electro-magnet having its coil included in the arc-circuit, the opposing poles of the armature and magnet being of like sign, all substantially as set forth.

4. In an electric lamp, the combination of an electro-magnet having its coil included in the arc-circuit, a swinging frame having an armature opposed to said electro-magnet and wound with wire, forming a derived circuit around the arc, a bar, N, jointed to said frame and made in the form of an inverted T, pivoted levers *k*, jointed to the arms of said bar, clamps *j*, jointed to said levers, carbon-carrying rods E, lever R, connected with frame O, and spring P, attached to said frame and furnished with adjusting-screw Q, substantially as described and shown.

5. In an electric lamp, the combination of upper and lower carbons, means, substantially such as described, for separating and feeding said carbons, and a cut-out controlled by a differential magnet independent of the magnet employed to separate the carbons, substantially as explained.

6. In an electric lamp, the combination of a main or light circuit, a normally-open shunt or short circuit around the lamp, a closed derived circuit of high resistance, an electro-magnet wound with opposing or neutralizing coils, and an armature adapted to be attracted by the electro-magnet when the latter is energized to open the short circuit when attracted, and to close said short circuit when released.

7. In an electric lamp, the combination of a main or light circuit, a normally-open short circuit around the arc, a permanently-closed derived circuit of high resistance, an electro-magnet independent of the magnet controlling the carbons, wound differentially with coils in the main circuit and high-resistance circuit, and a device adapted to be controlled by the differential action of said electro-magnet to open and close the short circuit.

8. In combination with an electro-magnet in the light-circuit of an electric lamp adapted to effect the separation and feeding of the carbon, an electro-magnet wound with a coil in the light-circuit and with a neutralizing-coil in a derived circuit, an open short circuit across the lamp around the arc, and an armature having one end within the field of attraction of the differential magnet and the opposite end adapted to fall and make or complete the short circuit when not elevated by said differential magnet.

9. In combination with the light-circuit of an electric lamp, electro-magnet *t*, provided with two opposing coils, one in the light-circuit and the other in a derived circuit around the lamp, and armature Y, in metallic connection with short-circuit wire W, and adapted to make or close connection with the outgoing end of the light-circuit wire when not attracted by the differential magnet.

Witnesses: JOHN F. KELLY.
WATTS T. LOOMIS,
C. VAN VECHTEN.