(No Model.) 4 Sheets—Sheet 1.

S. F. VAN CHOATE.

ELECTRIC ARC LAMP.

No. 302,061. Patented July 15, 1884.

Fig. 2

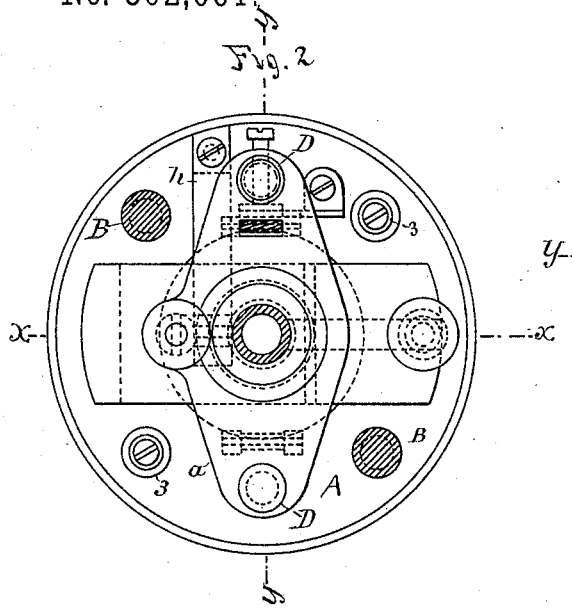


Fig. 1

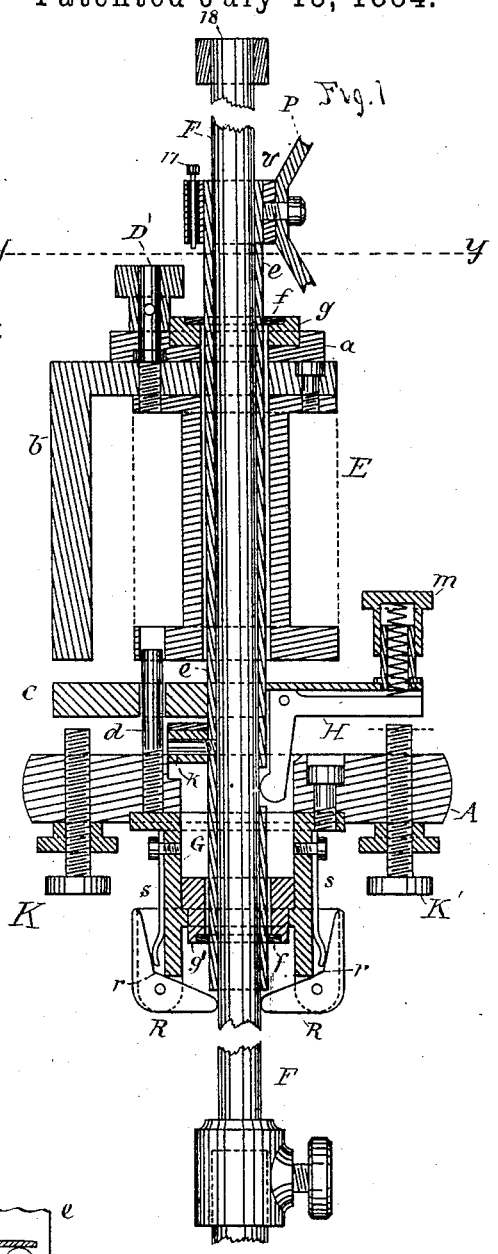


Fig. 5.

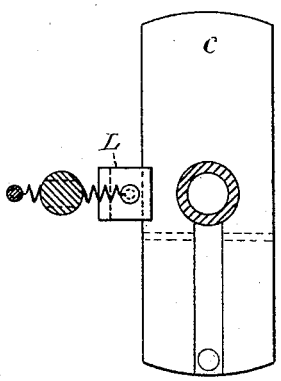
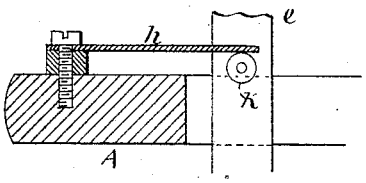


Fig. 10.



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4 Sheets—Sheet 2.

S. F. VAN CHOATE.

ELECTRIC ARC LAMP.

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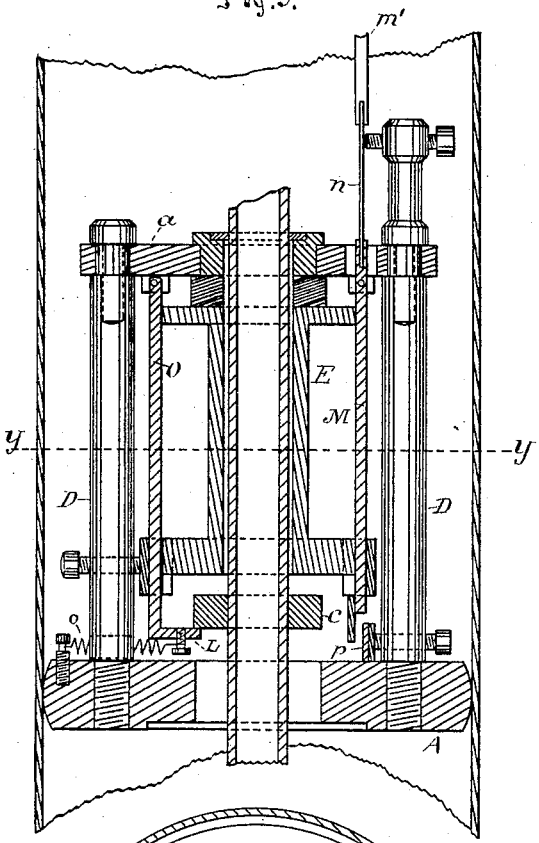
Fig. 3.



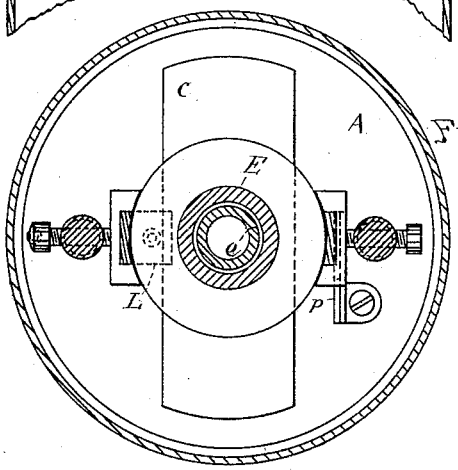
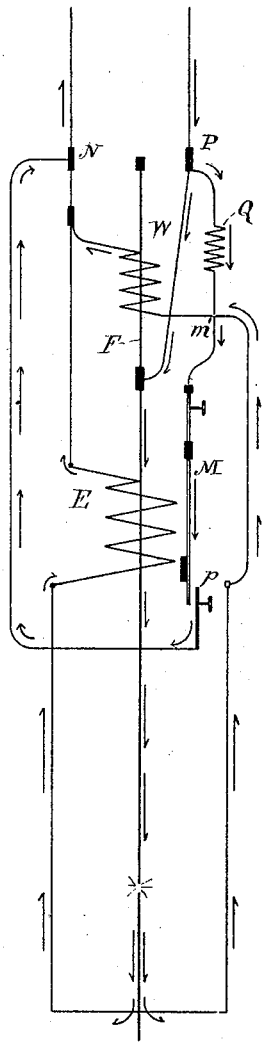


Fig. 4.

Fig. 6.



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4 Sheets—Sheet 3.

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ELECTRIC ARC LAMP.

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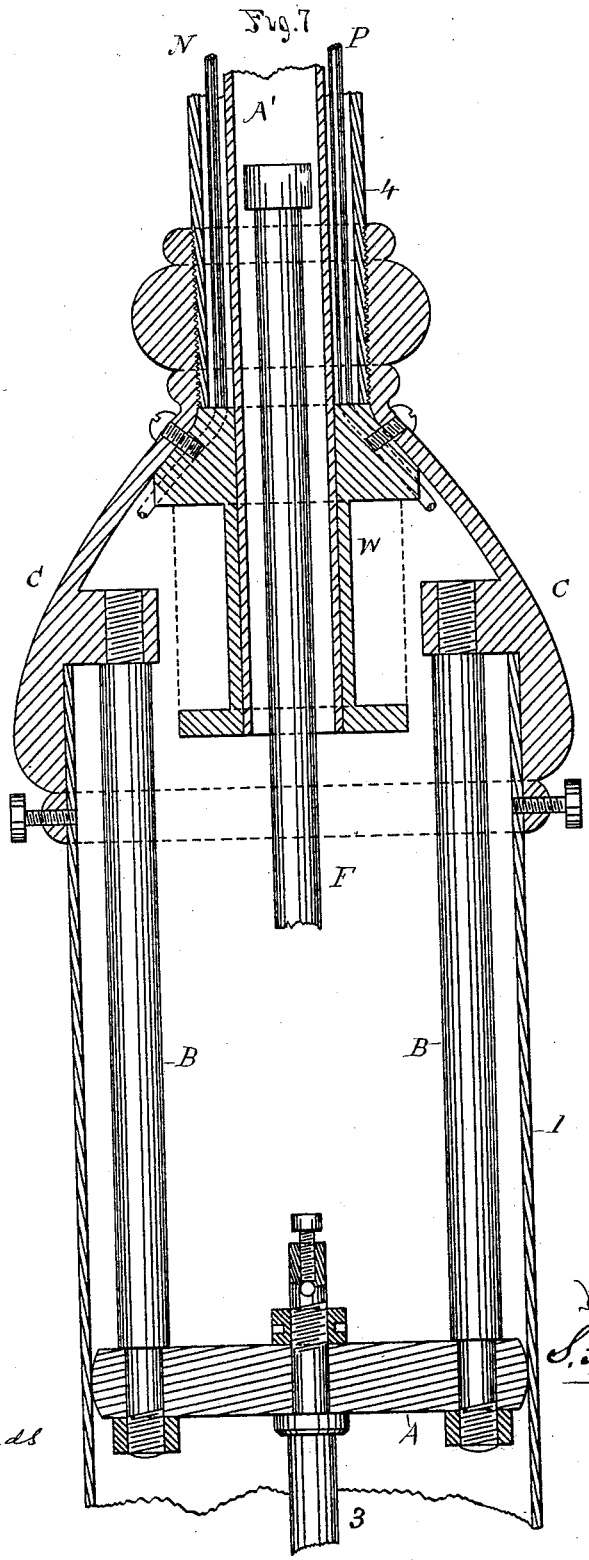
Fig. 7



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S. F. VAN CHOATE.

ELECTRIC ARC LAMP.

No. 302,061. Patented July 15, 1884.

Fig. 9

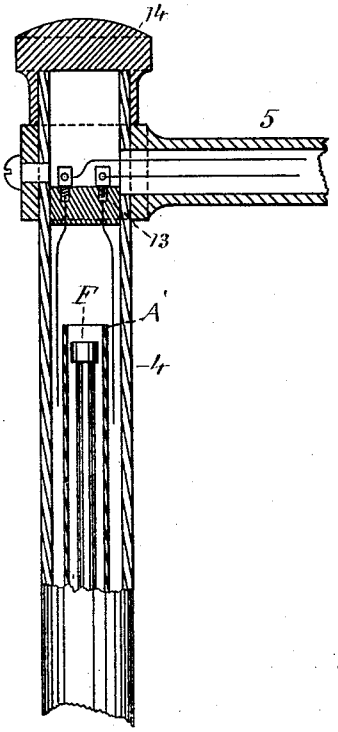
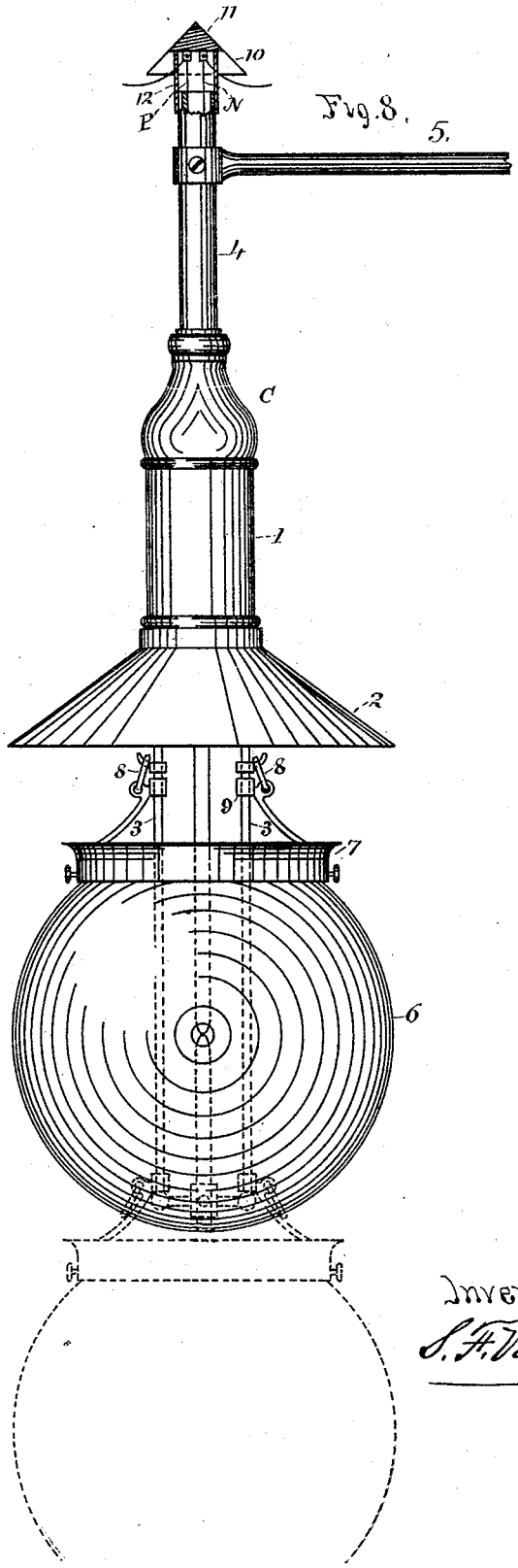


Fig. 8.



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Inventor
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H

UNITED STATES PATENT OFFICE.

SILVANUS F. VAN CHOATE, OF NEW YORK, N. Y.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 302,061, dated July 15, 1884.

Application filed June 12, 1882. (No model.)

To all whom it may concern:

Be it known that I, SILVANUS F. VAN CHOATE, 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 Electric Lamps, of which the following is a specification.

The objects of my invention are to produce an electric lamp that will give a more steady light than any similar arc light, and with less expenditure in electrical energy, and at the same time susceptible of being formed with a higher artistic appearance, and also free from many of the serious defects of other arc lamps. I attain these objects by introducing several new features, among which may be mentioned the following: first, the introduction and peculiar arrangement and combination of two distinct automatic feed movements in regulating the carbons, one of which I call the "abnormal feed" and the other the "micrometer-feed," the former acting automatically without magnetic influences, and the latter acting under the restraint of magnetic action; second, the peculiar arrangement of magnets, coils, and circuits by which a very low resistance in the lamp to the action of the electric current is attained; and, finally, the peculiar arrangement of the reflectors, globes, supports, and casings, by means of which more pleasing and artistic effects are attainable.

In the accompanying drawings, Figure 1 is a vertical central section of the working mechanism of the lamp on the line *x x* of Fig. 2. Fig. 2 is a top view of the same, the part on the line *y y*, Fig. 1, being shown in section, and shows the relative position upon the insulated plate supporting the lamp mechanism of the posts supporting the various parts. Fig. 3 is a vertical central section of the working parts of the lamp, taken on the line *y y* of Fig. 2 at right angles to the section, Fig. 1. Fig. 4 is a horizontal section on the line *y y*, Fig. 3. Fig. 5 is a plan view of the main armature, looking at the same from beneath, and shows the stop-catch. Fig. 6 is a diagram of the connections and circuits in the lamp. Fig. 7 is a vertical central section of a casing for the working parts of the lamp, and shows the manner of supporting the plate or table which carries the lamp proper. Fig. 8 is an elevation of the complete lamp, showing the globe, reflector, casing, and supporting-arm. Fig. 9 is a vertical central section illustrating a modified construction of the supporting-arm, the tube carried thereby, and the devices for making electrical connections between the main-line conductors and the lamp. Fig. 10 is a detail view.

A, Figs. 1, 2, 3, 4, and 7, represents a supporting plate or disk for the operative mechanism of the lamp, preferably of an insulating material, and hung, by means of rods B B, Figs. 2 and 7, from the interior of the cap-piece or hood C, in the manner clearly shown in Fig. 7.

D D, Figs. 2 and 3, are standards rising from the plate A, and connected at their top by a cross-piece, *a*, Figs. 1, 2, and 3, from which latter the spool of the regulating electro-magnet of the lamp is supported.

E represents the spool, upon which are wound the usual coil or coils, connected in the ordinary manner with the general circuits supplying current to the lamp, which spool is of iron or similar magnetic material, and is provided with a pole-piece, *b*, clamped to its upper head, and extending downward into line with its lower head, so as to form, in effect, a horseshoe-magnet, both poles of which act upon the armature *c*, by which the feed mechanism is actuated or controlled.

The extension *b* may be formed or cast in one piece with the spool, if so desired. D', Fig. 1, indicates a supporting and adjusting screw mounted in the cross-piece *a*, for supporting and adjusting the spool or regulating magnet E by means of a screw-thread on its lower end, said spool being prevented from turning, and being also guided, by a pin, *d*, projecting upward from the plate A through the armature into a perforation in the lower spool-head.

The center of the spool or magnet E is made in the form of a hollow cylinder, as indicated, to form a path for the carbon-carrier F, and a metallic sleeve, *e*, preferably of brass, fitted nicely to said carrier, so as to make good contact therewith, but at the same time to move longitudinally upon said carrier, or to allow the carrier to be moved within it. The sleeve

e is guided at its two extremities by rings or washers *f f*, preferably of steel, which are fixed one in sleeve of insulating material *g*, mounted in the cross-piece *a*, and the other in an insulating-sleeve, *g'*, supported by a flange formed upon the interior of a short tube, G, which latter is supported beneath the plate A by means of screws, which enter a flange at the top of the tube in the manner indicated.

At *h* is indicated a blade-spring fixed at one end to a stud projecting upward from the plate A, and bearing at its free end upon the upper side of an insulated pin, *k*, projecting from the side of the tube *e*, so as to tend constantly to force the latter downward with a force sufficient to remove the knuckle-joint levers R R from contact with the carrier, as well as to move the armature and carrier F downward promptly. This device is shown in detail in Fig. 10.

Fixed to the tube, so as to move with it or to carry it upward against the action of the spring when attracted by the regulating-magnet, is the armature *c* of the regulating electro-magnet, in or on which armature is pivoted a spring-actuated friction clutch or dog, H, here shown as in the form of a bell-crank lever, although other forms might be employed. One arm of said lever is rounded at its end, where it forms a friction toe or clamp bearing against the side of the carbon-carrier, while its other end is acted upon by a coiled spring, which is held in a tube mounted upon the armature, and tends to hold the friction-toe in engagement with the carrier with a force regulated by an adjustable cap, *m*, secured upon the upper end of the tube containing the spring. The amount of friction is to be adjusted to such a degree that the carrier will be held from feeding, and when the tube and the connected armature move downward the carrier will be moved downward by a positive action, but that the toe can slide over the surface of the carrier when the latter is held from upward movement, and said toe and its actuating-armature are lifted by the attraction of the regulating electro-magnet.

K is an adjustable stop for the armature, which stop may be adjusted to determine the length of arc that shall be formed when the lamp begins to act, as will be presently more clearly seen, while K' is a second adjustable stop adjusted slightly above the line of the stop K, and immediately beneath the horizontal arm of the friction-clutch H, so that if the armature and the connected clutch drop to a sufficient distance to bring the horizontal arm into engagement with the stop the friction-toe will be removed from engagement with the carrier, which will then drop freely. The latter stop I term the "abnormal feed-stop" or releasing device, which in the normal operation of the lamp does not come into action, the operation of feeding the carrier to compensate for combustion of the carbon being brought about by the movements of the armature between the spool and a second stop, to be presently described, which stop I term the "auxiliary" or "micrometer" stop, and which is applied so as to prevent the armature from dropping back to a point where the friction-clutch will be released. The latter stop is under the control of any suitable electro-magnet energized from the lighting-circuit. In the present instance, for the purpose of simplification, I employ the regulating electro-magnet of the lamp for this purpose. Said stop, when set in position, allows only a very small range of movement of the armature, which, by the means of devices to be presently described, results in the production of what I term the "micrometer" feed.

The auxiliary or micometer stop is shown at L, Figs. 3, 4, and 5, attached to or formed upon the end of an armature-lever, O, which is pivoted between ears formed upon the cross-piece *a*, and which bridges and is attracted by both spool-heads, forming an armature or keeper across both heads. To the armature L is applied a retracting-spring, *o*, Fig. 3, or equivalent retracting device, which, when the attraction ceases or becomes sufficiently weakened, withdraws the stop out of range of the armature-lever, and allows the latter to drop back sufficiently to release the friction-toe H. The tension of the retractor *o* is, however, so slight that during the ordinary operation of the lamp it cannot overcome the attraction of the magnet. If, however, the attraction be diminished by extinction of the arc, or by the formation of an abnormally long arc, the retractor will act, withdrawing the stop and completely releasing the carbon-carrier by removing the operative portion of the friction holding and feeding device—viz., the friction-toe H.

R R represent two clutch-levers pivoted in ears formed upon the tube G, and pressed into engagement with the carbon-carrier F by light springs *s*, or equivalent device. The function of these levers or dogs is to prevent the carrier from being lifted during the upward movement of the tube and the clutch H, their operation in this respect being due to the fact that the dogs impinge against the carrier on a line below their pivotal line of support, so that when the carrier begins to move upward the levers or dogs are caused to bind against it and stop its movement under the lifting action of the friction-clutch H, the latter then sliding on the surface of the rod. The carrier may, however, move downward freely between them, as when moving in this direction it tends to separate the levers. The carrier may, however, be moved upward at any time by hand by the exertion of a sufficient force to overcome the set pressure of the two dogs and the clutch H, since the former are prevented from knuckling beyond a certain degree by the shoulders *r*, which come down close to the upper edges of the dogs. The tube *e* extends downward to a point where, when the armature supporting it is fully released by the mag-

net, said tube will come into contact with the dogs and hold them out of engagement with the carbon-carrier. It is obvious that one dog only might be made to effect the purpose of the two. The employment of two is, however, preferable.

The plate A is made of insulating material, in order to insulate the lower carbon and its supports from the upper carbon and the lamp mechanism, the clutches bearing on the carbon-carrier and such other portions as are in electrical connection with the upper carbon.

The operation is as follows: When no current is passing and the magnet or magnets are not energized, the auxiliary or micrometer feed-stop L is withdrawn out of range of the armature by its retractor *o*, and the armature *c* rests against the abnormal feed-stops K K′, the latter of which withdraws the friction lifting and impelling clutch H, so that the carbon-carrier is free to drop and bring the upper carbon into contact with the lower. In this position of the parts the tube *e* holds the dogs R out of engagement with the carrier, the distance to which they are removed being determined by the adjustment of the stops K K′. When the current passes through the magnets of the lamp, the armature *c* is lifted, the first effect being to allow the clutch H to engage with the carrier and raise it, the dogs R being kept out of engagement with the carrier by the tube *e* until an arc of the proper length has been formed. The tube *e* then leaves the dogs, which come into engagement with the carrier and prevent further upward movement thereof, so that during the remaining upward movement of the armature the clutch H slips upon the carrier. The time at which the dogs shall be allowed to engage with the carrier, and the consequent length of the arc, is determined by the adjustment of the stops K K′, as above stated. The armature *c* is drawn upward against the poles of the magnet, but is prevented from sticking by means of a facing of copper, mica, or other non-magnetic material, applied to the poles or to the armature. Simultaneously with the attraction of the armature *c* the auxiliary or micrometer feed-stop L is operated by the armature O, and is set beneath the armature *c*, so that its downward movements are limited thereby, and the clutch H cannot be disengaged. The armature now plays between the poles of the magnet and the auxiliary stop and produces the micrometer feed in the following manner, the extent of its movements and the fineness of the feed being graduated by the adjustment of the magnet by means of the supporting-screw D′: When, owing to consumption of the carbons, the strength of the magnet decreases, the tube *e* and connected armature *c* are carried downward by gravity and by the action of the spring *h*, and the carrier is fed downward by the action of the friction-clutch H, its movement not being opposed by the dogs R. When, owing to the resultant increased attraction of the magnet, the armature is immediately raised again, the carrier is prevented from rising with it by the action of the dogs R, which lock it from upward movement, and the clutch H then takes a new position on the carrier, ready for the next downward feed.

In the micrometer-feed movement the tube *e* does not drop far enough to come into contact with or operate the dogs R. If from any cause the attraction of the magnet diminishes so far that the auxiliary stop L is withdrawn, the armature then recedes so as to come into contact with the stops K K′, whereupon the carrier is released entirely and drops until the carbons come into contact, as before described. If the lamp be in condition to resume its operation, the armature is immediately attracted again, the arc formed, and the micrometer feeding action again comes into play, or the carbons remain in contact, if the release has been produced by switching the current from the lamp, until the magnet is energized by turning on the current again.

In addition to the feed-regulating armature *c* and the auxiliary-stop armature O, I apply to the electro-magnet E, in a similar way to armature O, another armature, M, which serves to complete a cut-out or safety circuit around the lamp when the arc is extinguished or becomes abnormally lengthened. This armature, like armature O, forms a keeper across the two heads of magnet E, and is pivoted from the cross-plate *a*, as shown. One branch of the safety-circuit wire is indicated, at *m′*, as atttached to a blade-spring, *n*, projecting from and soldered into the end of the armature and serving as a retractor for the armature, and a means of conveying the current thereto without passing through the pivots by which it is supported. The other branch of the safety-circuit is connected to an adjustable spring contact-stop, *p*, mounted upon plate A, and adjustable by a set-screw passing through a post, D. A contact upon the end of armature-lever M serves to complete the circuit. The tension of the spring *n* is adjusted by a set-screw passing through an extension from top of post D. Other means for retracting the armature might be employed.

It is evident that the armature O might be utilized for closing the cut-out circuit and the armature M dispensed with. I prefer, however, to employ the two armatures, as it is desirable to set the retractor of the armature O so that it will act with a less degree of diminution in the strength of the magnet than will the armature M.

In order to attain as low a resistance to the electric current as possible in the lamp-magnets, and to enable me to make the magnet of small dimensions, I form around the magnet E a branch circuit embracing a bobbin of wire wound upon a spool, W, preferably of insulating material, Fig. 7, the resistance of which bobbin is sufficient only to divert the necessary portion of the current into the electro-

magnet E for energizing the same. As the current flows in multiple arc the resistance is lessened over what it would be if all of the current were compelled to pass through the regulating electro-magnet. The liability of the latter to injury by heating from the electric current is also avoided.

The spool W is fixed in the top of the cap-piece C in any suitable manner, and is made hollow to form a passage for the carbon-carrier F and a support for an auxiliary tube, A′, which serves to protect the carrier F from being jammed or interfered with by the conducting-wires, which pass down to the lamp through the space between said tube and the outer tube, 4, which latter supports the whole lamp structure. Electrical connection with the carrier is made through its encircling tube *e*, which latter carries a metallic collar, *v*, at its upper end, to which the positive main conductor P is screwed or clamped by any suitable means.

At 17 is shown an insulated contact supported in a collar at the top of the tube *e*, with which contact a collar, 18, upon the carrier comes into connection for the purpose of closing an electric circuit to a mechanism which will change the circuit to another lamp.

The remaining electrical connections of the various parts are made in the ordinary way, and the paths of the currents when the parts are connected up are clearly indicated by the diagram, Fig. 6, where the parts already referred to are designated by the same letters, P representing the positive main conductor, and N the negative. A resistance, Q, is inserted, when desired, in the cut-out or safety circuit, as indicated, so that the resistance of said circuit when closed shall be approximately equal to that of the circuit through the arc.

Referring to Figs. 7, 8, and 9, the protecting-casing for the lamp is indicated by the figure 1, said casing being secured by screws, as indicated, or by other means, to the cap-piece C. To the lower end of the casing 1 is secured the reflector 2, which may be made in one piece with the tube, if desired, and of tin or any other material. The cap-piece is sustained from a bracket, 5, by a tube, 4, which screws into the top of the cap-piece C, and is embraced by a ring or collar attached to the end of the bracket. The rods which support the lower carbon, and are indicated at 3 3, extend downward from the plate A within the inclosing-globe 6, and at their bottom are connected by the cross-piece by which the lower carbon is supported. In case of a double-carbon lamp there would be but one rod in the center, carrying at its lower end a cross-head, on either end of which the two carbons would be supported. In either case the rod or rods and the cross-piece at points below the arc are entirely free from any attachments whatever, and hung suspended and entirely disconnected from the globe or any other supporting devices. These rods are fixed to the plate A, and are shown in Figs. 2 and 7 as projecting up through the plate and fastened by nuts or screws.

The globe 6, solid or continuous at its bottom, is inverted, and its ring or holder 7 is supported by arms provided at their ends with links 8, which hook onto projections secured to the rods 3. By detaching the links 8 the globe may be lowered to the position indicated in dotted lines, so as to allow access to the lamp for renewal of the carbons. The upper ends of the supporting-arms for the globe-holder are formed into guide sleeves or tubes 9 9, which slide freely up and down upon the rods 3 3, and catch upon the cross-support, so as to support the globe when it is lowered for renewing the carbons, or for any other purpose. By constructing the globe so that it is continuous at its bottom, as shown, and by supporting it in the manner described, more pleasing effects are attained, and no shadows are produced, either to the sides of or below the light, by the supporting and holding parts for the globe.

The positive and negative conductors are carried down through the tube 4 from binding-posts mounted on insulating material 11, fixed on the inside of a bonnet or hood, 10, which is supported by posts 12, rising from the tube 4.

Fig. 9 shows a construction in which the conducting-wires are brought to the lamp through the hollow bracket 5, instead of through the top of the tube 4. A block of insulating material, 13, is fixed in the interior of the tube 4, at a point just below the opening of the hollow bracket, and carries the binding-posts by which the electrical connections are made. An opening is formed in the side of the tube 4 to match with the opening of the bracket, and the tube itself is screwed into a sleeve formed on the end of the bracket, or is fastened in any other suitable manner. A cap, 14, screws upon and closes the upper end of the tube 4.

The arrangements of Figs. 8 and 9 are intended, mainly, for application to lamps designed for outdoor use. When the lamps are used indoors, the tube 4 may extend up and be fastened to the ceiling and the wires carried off through the tube, the bracket 5 being dispensed with.

It is obviously within the scope of my invention to control the armature-lever O, which operates the auxiliary stop, by an additional electro-magnet, instead of by the electro-magnet which controls the feed devices. The arrangement shown is, however, preferable on account of its compactness. I may use other constructions and forms of electro-magnet in place of the magnet E. Other modifications will readily suggest themselves to those skilled in the art.

The electro-magnet E may be wound in any of the ways known in the art—either with wire in the main circuit only or differentially. I

do not limit myself to controlling the auxiliary or micrometer feed stop by the agency of magnetism, as it is obvious that it may be operated by other means besides magnetic means, my invention consisting in the combination, with the armature which controls or operates the feed-regulating devices, of two stops or sets of stops, one of which is applied by any means to limit the movement of the armature during the normal operation of the lamp in feeding, but is withdrawn to allow the armature to recede sufficiently to come into contact with the other set when the arc is extinguished or becomes abnormally lengthened.

In another application for patent, filed as a division of this application, I show and claim the following combinations, to wit:

"The combination of the armature, the carrier-tube to which the armature is fixed, the magnetic spool-head, the friction lifting and impelling clutch pivoted in the armature, and the fixed stop for releasing the clutch.

"The combination, with the carrier F, of a pivoted clutch or dog, R, having a rounded head, and applied, in the manner described, to arrest the upward movement of the carrier, and means for checking the movement of said clutch, so as to allow the carrier to be forced up by hand.

"In combination with an electric lamp, one or more pivoted dogs oscillating on stationary centers or bearings, and having one end resting against the carbon or carbon-carrier, and acting to prevent the carbon or carbon-carrier from moving upward when the feed-armature rises.

"In combination with an electric lamp, one or more pivoted dogs uninfluenced or acted on by any magnet, but oscillating on stationary centers or bearings, and operated in the manner described, said dogs having rounded ends, and being arranged so as to allow the carbon or carrier to be moved up and down by hand, notwithstanding the wedging or clamping tendency of said dog or dogs while the armature is attracted by its magnet.

"The insulating-plate A, in combination with the rod or rods B B, and the cap-piece, substantially as described.

"The combination of insulating-plate A, the inclosing case or tube I, and the cap C, for the purpose described.

"In an electric lamp, an adjustable magnet combined with the feed mechanism, in the manner described, to determine the exact distance to which the carbon or carrier shall be fed at each operation of the magnet's armature.

"The combination, with the magnetic spool E, of the safety cut-out armature M, bridging the spool-heads.

"The combination, with the supporting cross-piece *a*, of the hollow magnet-spool E and the armatures O M, hung from the cross-piece and bridging the spool-heads."

I do not wish to be understood as making claim herein to the above-specified combinations.

What I claim as my invention is—

1. The combination, with the feed-regulating armature for an electric lamp, of a stop or catch for limiting the movement of said armature in the operation of controlling the feed, and means for bringing said stop or catch into operative position after the armature has been attracted by its magnet.

2. The combination, with the feed-regulating armature of an electric lamp, of an auxiliary armature for limiting or shortening the movement of the former, whereby a limited play of the armature in producing a feed shall be allowed, and whereby said armature may be permitted to fall back upon its more remote stop when the current actuating the magnet becomes so weak that the magnet's power is not sufficient to hold the auxiliary armature in position to limit the movement of the feed-regulating armature.

3. The combination, with the feed-regulating armature for an electric lamp, of a lifting and feeding clutch, a releasing-stop, and an auxiliary stop and armature, arranged in the manner described, for limiting the movement of the feed-regulating armature during the normal feed, and preventing contact of the lifting-clutch with its releasing-stop.

4. The combination, with the feed-regulating armature of an electric lamp, of an auxiliary armature for limiting the reverse movement of the former after it has been attracted by the magnet, a stop operated by said micrometer-feed armature, and set thereby beneath or in range of the feed-regulating armature, and a retracting device adjusted below the strength of the normal current for withdrawing the said micrometer-feed armature when the arc is extinguished or abnormally lengthened.

5. The combination of an armature, a pivoted spring-actuated clutch engaging with the carbon-carrier, a releasing-stop for said clutch, and an auxiliary armature or stop controlled by the action of an electro-magnet, and arranged in the manner described, to confine the movements of the main or feed armature within a range in which the clutch will not come into contact with its releasing-stop.

6. The combination of the armature *c*, fixed to and moving with the carrier-tube, the elbow-lever-clutch H, pivoted in the armature, and a pressure-spring mounted in the armature and bearing against one arm of the lever.

7. The combination, with the armature and the friction-clutch carried thereby, of two stops, K K′, one of which is set to operate the clutch for releasing the carrier before the movement of the armature is stopped by the other.

8. The combination, with the armature and the clutch, of two adjustable stops—one ar-

ranged to arrest the movement of the armature and the other to release the carbon-carrier.

9. The combination, with the armature and the friction-clutch carried thereby, of a locking clutch or clutches controlled by the armature for stopping the upward movement of the carrier, and two adjustable stops.

10. The combination, with the armature, the locking clutch or clutches, and the friction-clutch, of two adjustable stops—one arranged to arrest the movement of the armature and the other to release the carbon-carrier.

11. The combination, with the carrier, of two pivoted dogs or clutches arranged to arrest the upward movement of the carrier, and a carrier-tube connected to the armature for holding said levers away from the carrier during formation of the arc.

12. The combination of a carrier, F, a friction impelling and lifting clutch pivoted on the armature, and adapted to slide in either direction upon the carrier, and the spring-actuated locking dogs or levers, applied to the carrier in the manner described, to arrest the upward movement thereof.

13. The combination of a carrier, F, a friction impelling and lifting clutch pivoted on the armature, a locking or clutch lever or levers applied to the carrier in the manner described, and a device fastened to and moving with the armature and clutch, and acting to hold the knuckle-joint lever or levers or dogs out of engagement with the carrier to allow the formation of the arc.

14. The combination of the carrier F, a friction impelling and lifting clutch, a locking or clutch lever or levers for arresting the upward movements of the carrier, and the carrier-tube *c*, acting upon the knuckle-joint levers or dogs to hold them out of engagement with the carrier during formation of the arc.

15. The combination of the carrier-tube *c*, the clutches or dogs applied to the carbon-carrier, and the spring *h*, applied to the carrier-tube and acting to remove the dogs from engagement with the carbon-carrier.

16. The combination, with the armature *c*, of an impelling-clutch carried thereby and engaging with the carbon-carrier, a back-stop for said armature, an actuating electro-magnet acting as the front stop, and means for adjusting the magnet to govern the length of feed at each movement of the armature.

17. The combination, with the magnet E, of the armature *c*, vibrating between a stop and said magnet-pole, the carrier-tube *c*, and means for adjusting the magnet for determining the reverse movement of the carrier-tube.

18. In an electric lamp, magnet E, composed of a hollow spool of iron provided with an extension, *b*, magnetically connected to one head of the spool and carried down into line with the other head, and a feed-regulating armature for adjusting the carbons.

19. The combination, with the magnetic spool E, of the armature-lever O, bridging the spool-heads and carrying the auxiliary or micrometer-feed stop.

20. The combination of the magnet E, provided with an extension, *b*, connected to one spool-head, an armature, *c*, for operating the feed mechanism, actuated by said magnet and extension *b*, and a supplemental cut-out armature bridging the spool-heads.

21. In an electric lamp, a magnet, E, provided with three armatures, one of which acts to form the arc, and is attracted by one direct pole, and an extension, *b*, from the other, and the other two of which are supplemental armatures bridging the spool-heads, one of said latter armatures operating a micrometer-feed stop, and the other controlling the automatic cut-out.

22. The combination, with the carrier F, of the protecting-tube A′, placed between the carrier and the external supporting-tube, 4, and the conducting-wires passing down within the space between the tubes.

23. The combination, with the magnet E, of the auxiliary spool or wire W, the terminals of which are connected with the terminals of the magnet E, said spool being arranged and constructed, as and for the purpose described, to lower the resistance and to permit the magnet to be made of small dimensions without danger of injury by heating.

Signed at New York, in the county of New York and State of New York, this 9th day of June, A. D. 1882.

SILVANUS F. VAN CHOATE.

Witnesses:

H. C. TOWNSEND,

THOS. TOOMEY.