(No Model.)

7 Sheets—Sheet 1.

J. J. WOOD.

ARC LIGHT.

No. 426,405. Patented Apr. 22, 1890.

FIG. 1.

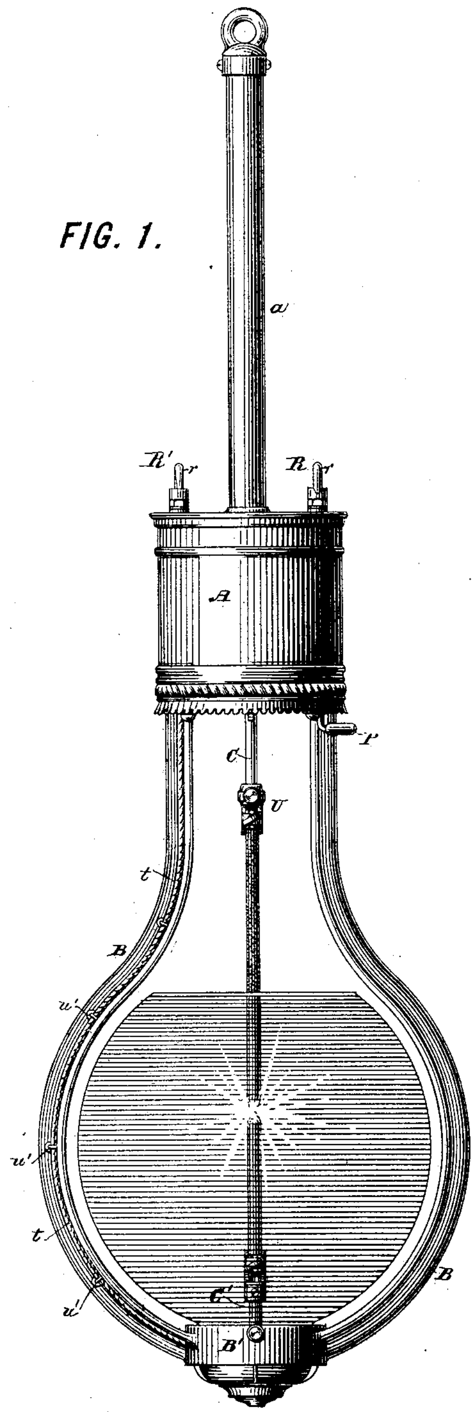
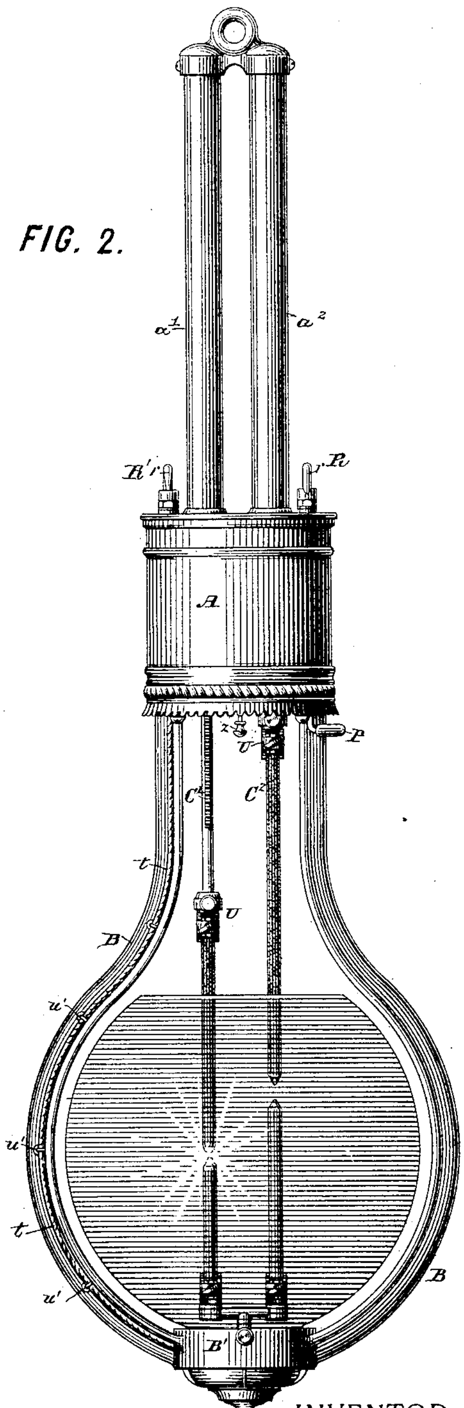


FIG. 2.



WITNESSES:

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C. E. Ashley

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By his Attorneys,
Arthur C. Fraser & Co.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.)

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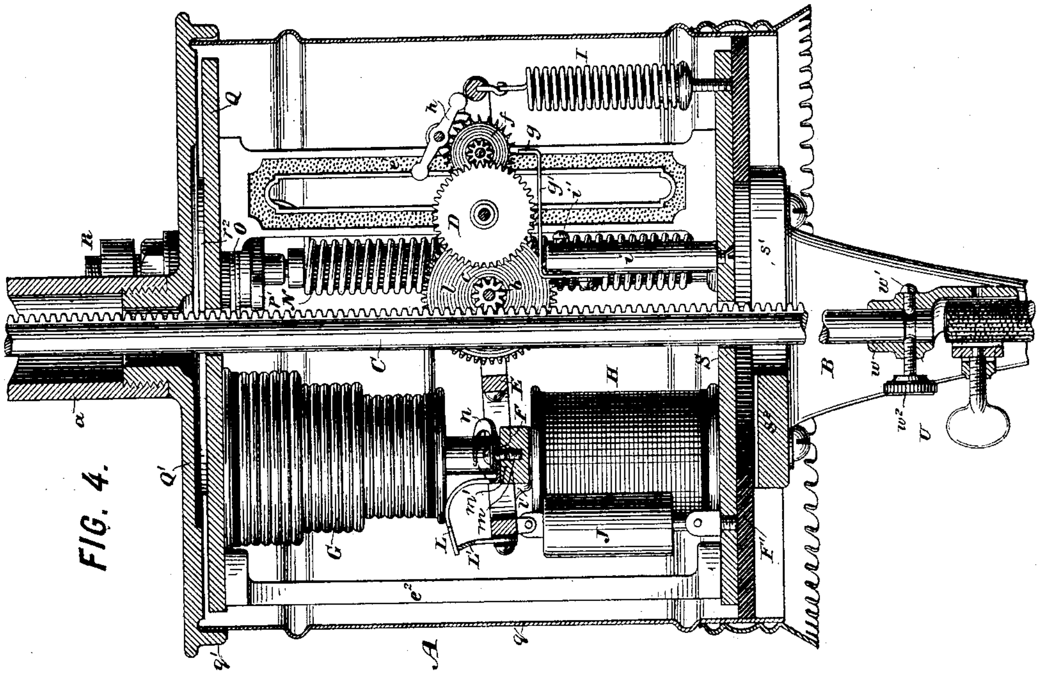

FIG. 4.

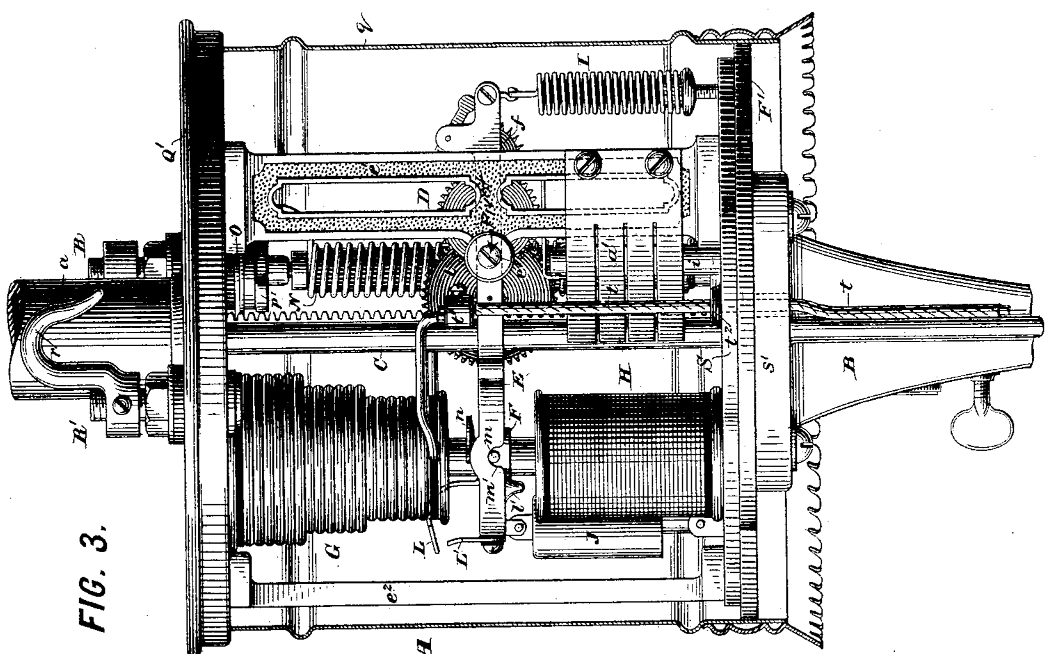

FIG. 3.

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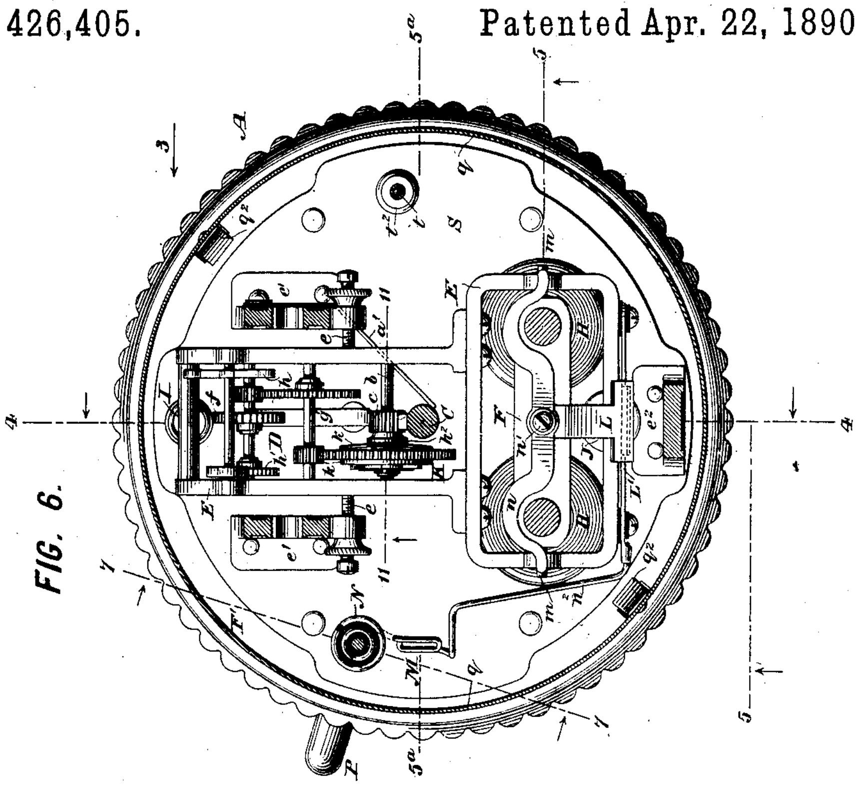

FIG. 6.

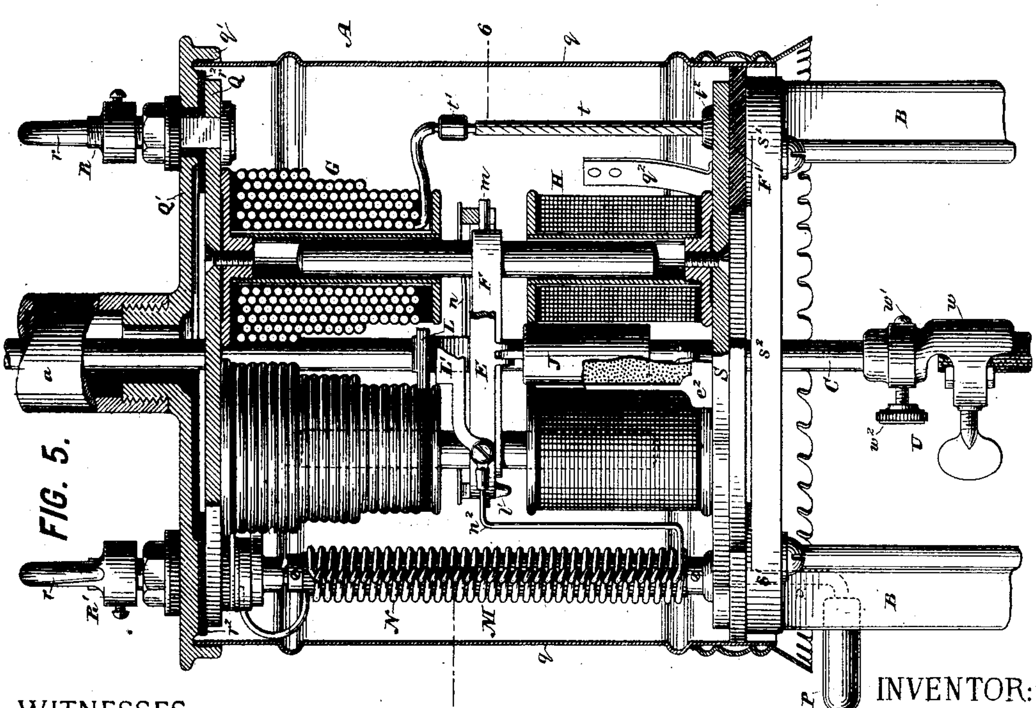

FIG. 5.

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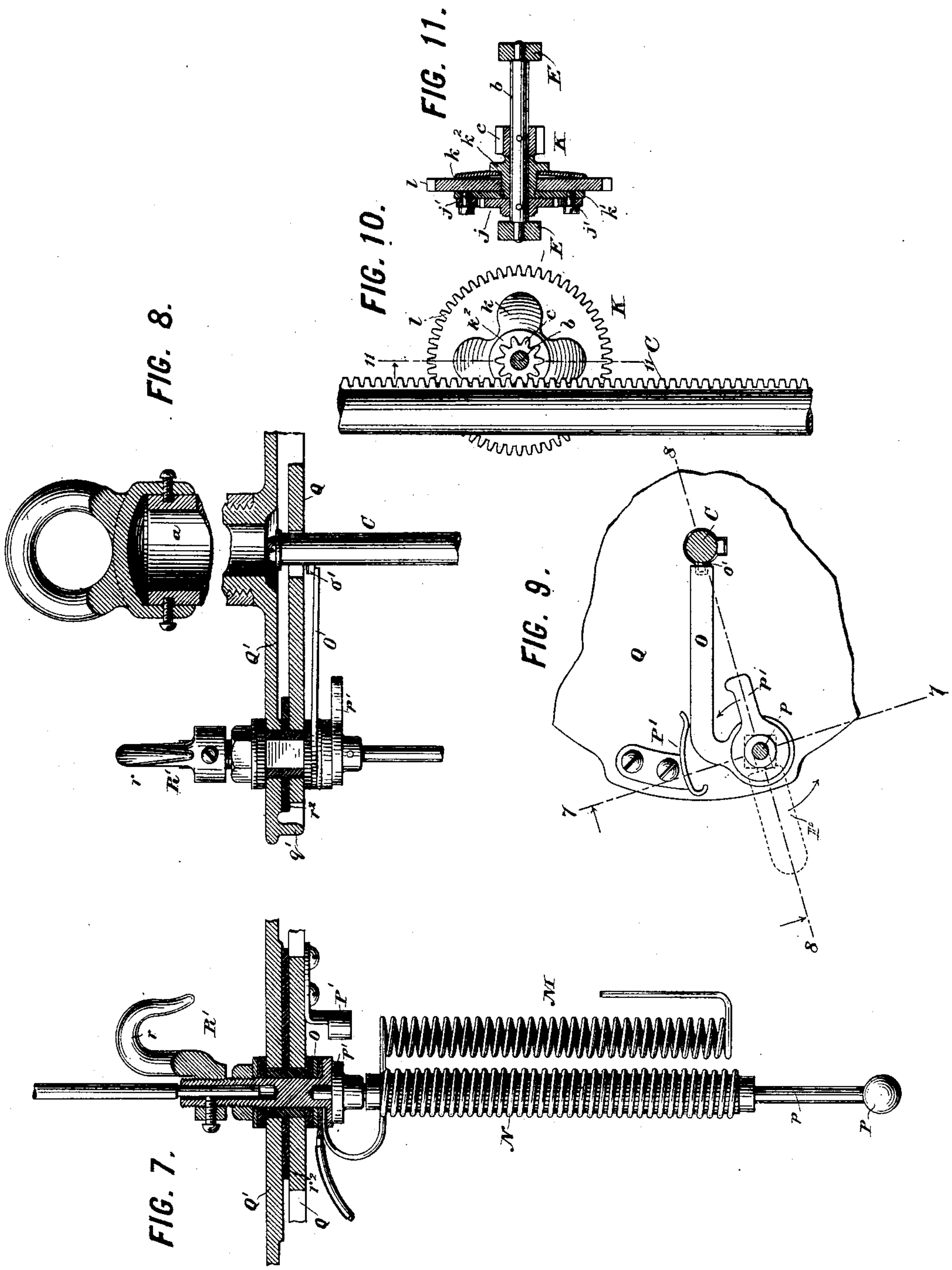

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FIG. 12.

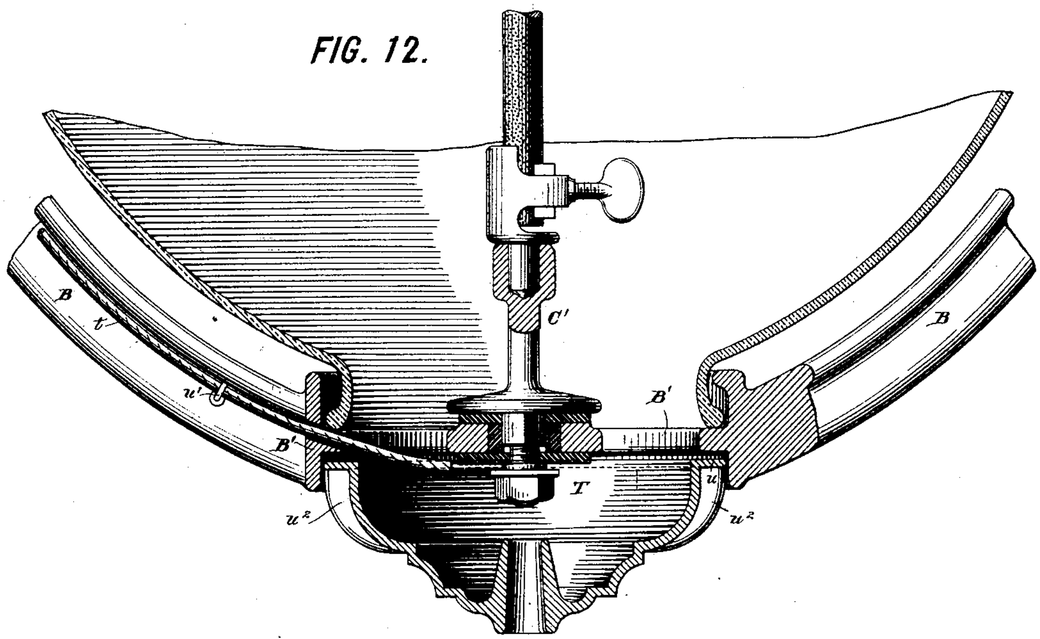


FIG. 13.

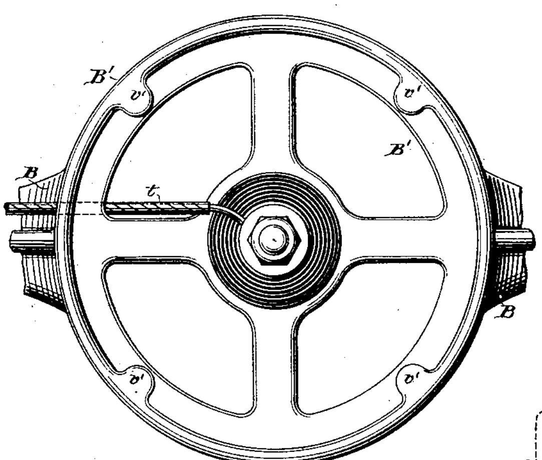


FIG. 14.

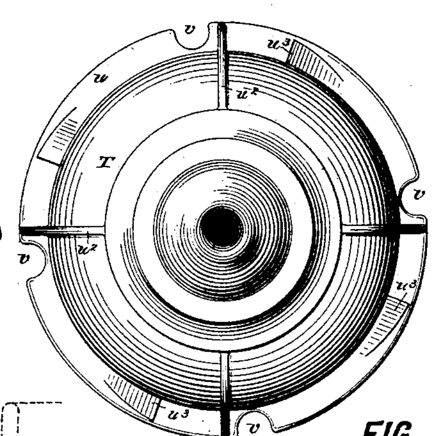
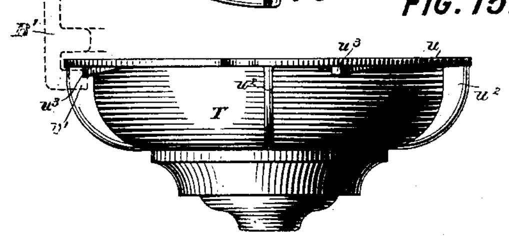


FIG. 15.



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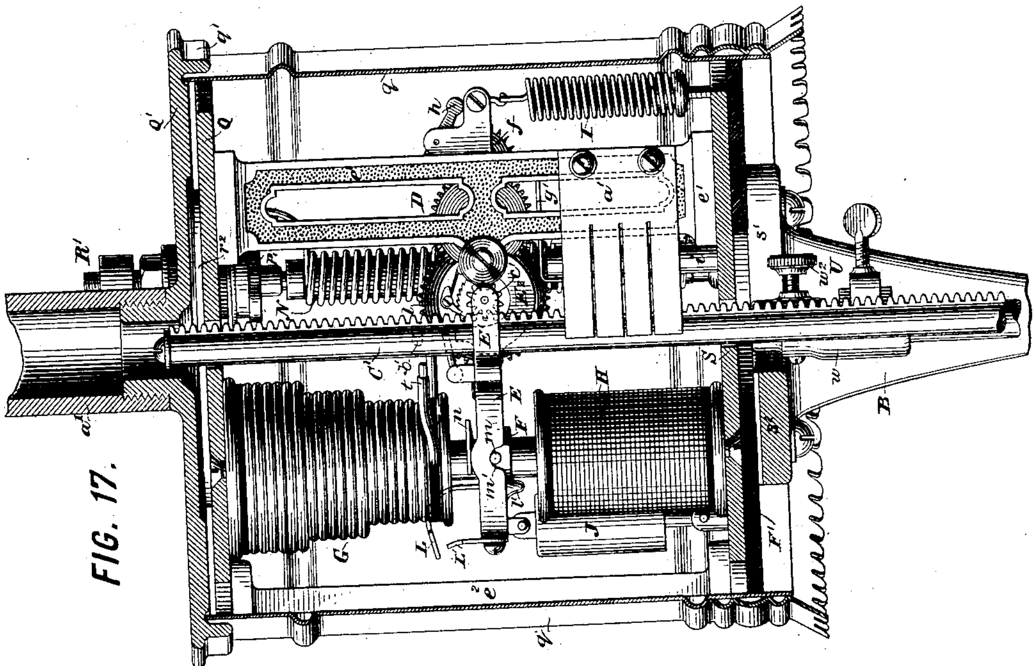

FIG. 17.

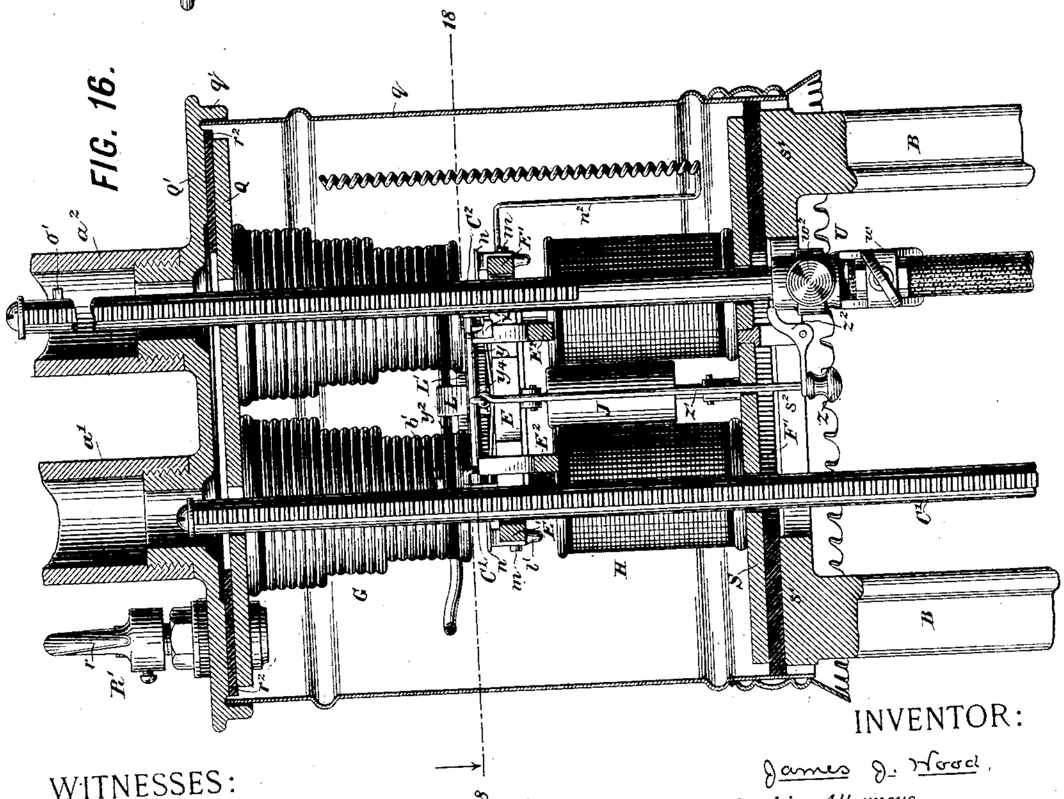

FIG. 16.

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(No Model.)

7 Sheets—Sheet 7.

J. J. WOOD.

ARC LIGHT.

No. 426,405.

Patented Apr. 22, 1890.

FIG. 20.

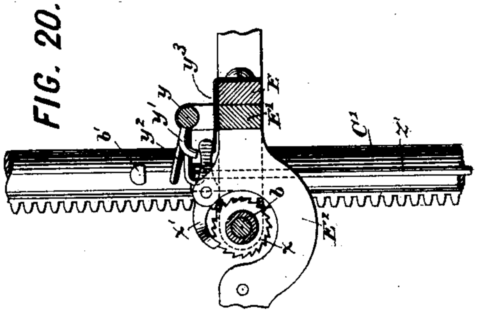


FIG. 21.

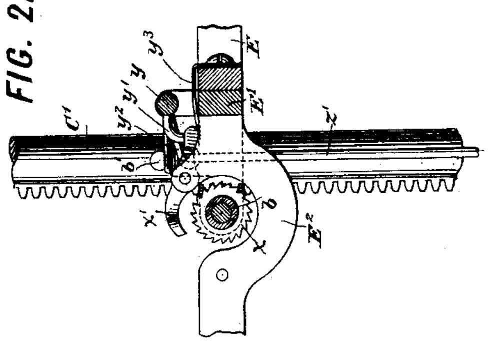


FIG. 19.

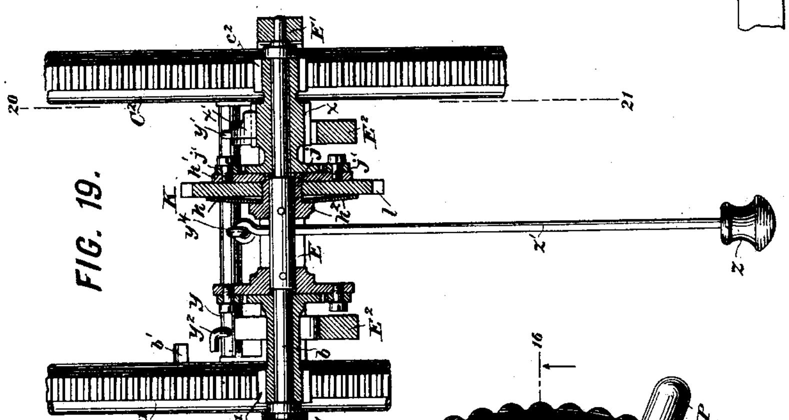
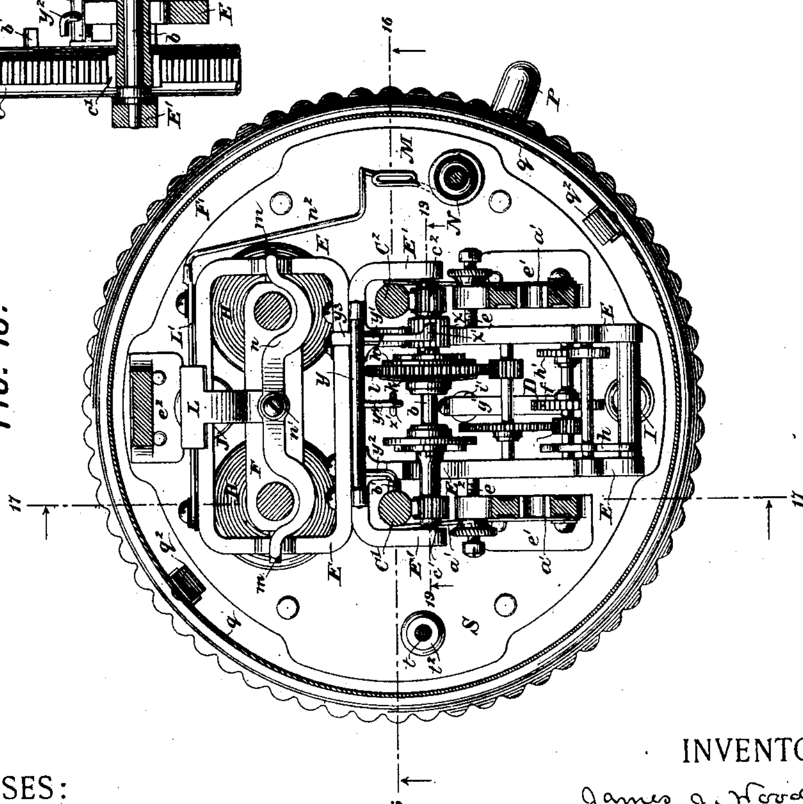


FIG. 18.



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UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF BROOKLYN, NEW YORK.

ARC LIGHT.

SPECIFICATION forming part of Letters Patent No. 426,405, dated April 22, 1890.

Application filed November 8, 1889. Serial No. 329,675. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. WOOD, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates to both single and duplex arc lamps, the complete invention being embodied in a duplex lamp.

The invention includes improvements in the regulating or feeding mechanism for feeding down the upper or positive carbon holder, in cut-out devices, in means for insulation, in carbon-clamps, in means for transferring the feed from the first to the second carbon-holder, in a duplex lamp, and in various accessory devices and details of construction.

In respect of the feeding mechanism, the lamps provided by my present invention are of that class having a rack-and-pinion feed, a lifting-magnet in the main circuit being provided to strike the arc, and a feeding-magnet in a shunt around the arc being arranged to act in opposition to the main-circuit magnet, and thereby to tilt the armature-lever from which the carbon-holder is hung through the medium of the rack-and-pinion connection, this tilting movement serving to release the feeding-gear and permit the carbon-holder to descend at a determined speed until by the shortening of the arc and the weakening of the shunt-magnet the opposite tilting movement of the lever arrests the feed.

My present invention is most directly an improvement, or series of improvements, upon lamps of the construction shown in the following patents granted to me, namely: No. 257,800, dated May 9, 1882, for electric-light regulator, and No. 384,817, dated June 19, 1888, for arc lamps, (relighting cut-outs.)

Figure 1 of the accompanying drawings is a front elevation, on a small scale, of my new single lamp; and Fig. 2 is a similar view of my duplex lamp. Figs. 3 to 15, inclusive, are views on a larger scale, showing the internal construction of the single lamp; and Figs. 16 to 21, inclusive, are views showing the duplex lamp. Fig. 3 is a side elevation of the lamp mechanism viewed from the left side, the tubular shell of the inclosing-case being in vertical mid-section. Fig. 4 is a vertical mid-section viewed in the same direction as Fig. 3. Fig. 5 is a rear elevation of the mechanism partly in vertical section on the line 5 5 in Fig. 6, the top part of the case being in section on the line 5^a 5^a therein. Fig. 6 is a horizontal section on the line 6 6 in Fig. 5. Fig. 7 is a fragmentary vertical section on the plane of the lines 7 7 in Figs. 6 and 9, showing the switch and binding-post and their connections. Fig. 8 is a fragmentary section through the roof-plate cut in the plane of the line 8 8 in Fig. 9. Fig. 9 is an inverted plan of a fragment of the roof-plate, showing the switch and final cut-out. Fig. 10 is a fragmentary elevation, looking in the same direction as Fig. 4, of the feeding-spindle and clutch. Fig. 11 is a diametrical section of this spindle with its pinion, gear, and clutch cut on the line 11 11 in Figs. 6 and 10. Fig. 12 is a vertical mid-section of the lower part of the lamp, showing the negative-carbon holder, globe-holder, and ash-cup. Fig. 13 is an invented plan of the globe-holder with the ash-cup removed. Fig. 14 is an inverted plan of the ash-cup detached, and Fig. 15 is a side elevation thereof. Of the views illustrating the duplex lamp, Fig. 16 is a vertical section in the plane of the axes of the carbon-holders, the plane being denoted by the line 16 16 in Fig. 18. Fig. 17 is a vertical section cut through the mechanism in the plane of the first carbon-holder, as shown by the line 17 17 in Fig. 18. Fig. 18 is a horizontal section cut in the plane of the line 18 18 in Fig. 16. Fig. 19 is a fragmentary vertical section, on a larger scale, in the plane of the axis of the feeding-spindle, as denoted by the line 19 19 in Fig. 18. Figs. 20 and 21 are fragmentary vertical sections in the plane of the line 20 21 in Fig. 19.

As my invention can be best understood by first examining the construction of the simpler form of lamp, I will first describe the single lamp with reference to Fig. 1 and Figs. 3 to 15, inclusive.

Referring to Fig. 1, it will be seen that the lamp is, in general, of ordinary construction, having a mechanism case or box A, a pendent looped frame B extending thence downwardly and terminating in a globe-holder B′, in which the usual glass globe is fastened, the lower or negative carbon pencil being carried in a negative-carbon holder C′, fastened to the lower part of the frame within the globe-holder, and the upper or positive carbon being carried by a carbon-holder or vertical-sliding rod C, movable up and down through the center of the mechanism case, and the portion projecting above the latter being housed in a protecting-tube *a*, all in substantially the usual manner.

The feeding or regulating mechanism in the case A is in general of similar construction to the mechanisms shown in my previous patents hereinbefore recited. The carbon-holder C is provided with rack-teeth which engage with a pinion *c*, fixed on the terminal spindle *b* of a feeding gear or train, designated as a whole by the letter D, this train being carried by an armature-lever E, which is fulcrumed between pivotal screws *e e*, Fig. 6, and is pivotally or otherwise connected to the armature F of two opposed electro-magnets G and H. The magnet G is wound with coarse wire and connected serially in the main circuit, being commonly called the "main magnet," while the magnet H is wound with fine wire, so as to develop a high resistance, and is connected in a shunt or derivation around the arc, being commonly called the "shunt-magnet." The magnet G is the lifting-magnet for lifting the upper-carbon holder when the circuit is established through the lamp, and thereby striking the arc. The magnet H is the feeding or regulating magnet for causing the upper carbon-holder to travel downwardly, in order to compensate for the wasting away of the carbons. Preferably these magnets G and H are of the solenoid type, the armature F which plays between them being of **H** shape, as heretofore, or, in other words, having essentially two **U**-shaped cores united so that their legs project in opposite directions and enter the respective solenoid coils. Thus the two magnets act oppositely to each other, one striving to move the armature in one direction and the other to pull it in the opposite direction. This is a well-known construction, as shown in my previous patents above referred to.

The armature-lever E is preferably made in the form of an open frame, as shown best in Fig. 6, being made at one end in the form of an open rectangular ring, within which the horizontal portion or cross-bar of the armature F is placed, and the remaining portion of the frame extending forward between two uprights *e′ e′*, as shown in Fig. 6, to which it is pivoted by screws *e e*. This portion of the lever is also an open frame, and within it is mounted the feeding-train D, which is carried by the lever. This train consists of the terminal pinion *c* on its spindle *b*, constituting one end of the train, and a stop-wheel *f*, constituting the other terminal of the train, with any suitable number of intermediate wheels and pinions for multiplying the motion imparted to the pinion *b* by the running down of the carbon-holder C in communicating this motion to the stop-wheel *f*, so that the latter shall revolve at a comparatively high velocity. This train is mounted in the lever E and participates in the movements thereof, the spindles of the train being extended between the opposite bars of the lever-frame and having their journals turning in these bars, as shown in Fig. 6.

Beneath the stop-wheel *f* is an elastically-mounted stop-tooth *g*, formed on or carried by a leaf-spring *g′*. When the armature-lever E is retained in its normal or mid position, as shown in Fig. 3, the stop-wheel *f* stands so low down that its teeth encounter the stop *g*, which prevents its rotation, and the train D consequently remains stationary. When, however, the arc becomes unduly long and its increased resistance diverts an increased current through the shunt-coil H, the added attraction of the latter draws down the armature and tilts the armature-lever until the wheel *f* is raised sufficiently to clear its teeth from the stop *g*, whereupon the carbon-holder C runs down until the arc is restored to its normal length, whereupon the lever E returns to its normal position and the train is again raised by the engagement of the stop with the stop-wheel.

To prevent the too rapid descent of the carbon-holder, the train is provided with a retarding device consisting of a vibrating bar *h*, actuated by an escapement, the wheel *h′* of which is fixed on the same spindle as the stop-wheel *f*. This general construction of feeding train or gearing is already known in the art.

It will be observed that the lever E is of the second class, in that the weight hanging from the pinion *b* is between its fulcrum *e* and the armature F. The main magnet G is arranged over the armature and the shunt-magnet H beneath it, which is the contrary of the construction heretofore employed by me; hence the magnet G, in lifting the armature, pulls upwardly on the lever and lifts the pinion *b* and carbon-holder C bodily, without its pull thereby increasing the pressure borne by the fulcrum-screws *e e*, so that the movement of the lever is accomplished with less friction and is more direct than heretofore, from which it results in practice that the lamp upon the turning on of the current instantly draws the arc to full length instead of drawing at first only a partial arc and leaving it to burn to full length by the wasting away of the carbons. The lever is extended on the opposite side of the fulcrum chiefly to make room for the feeding-train D, and also for the purpose of partially counterbalancing the lever. The stop-wheel *f*, being carried by the lever on the opposite side of the fulcrum, is moved up and down thereby, in order to engage with and disengage from the stop *g*, which, by reason of the location of the wheel *f* on this side of the fulcrum, is placed beneath the wheel, as shown. The further counterbalancing of the lever E is effected by a spring I, the tension of which is adjustable by means of a screw beneath it, which is secured to the lamp-case. By adjusting the tension of this spring the weight of the lever E and of the armature F, carried by it, can be more or less counterbalanced, and thereby the sensitiveness of the regulating mechanism to the attraction of the shunt-magnet H can be adjusted in order to determine the length of arc which the lamp shall maintain.

Heretofore the adjustment of the stop *g* to bring it into correct relation with the stop-wheel *f* has been effected by bending its spring-arm *g'*. The adjustment by this means is difficult, particularly when the stop is inaccessible by reason of its being located inside of other mechanism. To facilitate this adjustment, I provide the construction shown in Fig. 4, where the spring-arm *g'* is bent downwardly at its fixed end and fastened to a base *i*, provided with a screw *i'*, the end of which presses against the spring shortly above its fixed end. By screwing this screw inward the spring *g'* will be bent and the stop *g* be raised, and by screwing it outwardly the stop will be lowered. The spring *g'* becomes thus virtually an elbow-lever, the screw *i'* being arranged horizontally, in order to render it easily accessible by a screw-driver.

The armature-lever is connected to a dash-pot J, of usual construction, in order to resist any sudden or rapid movements and prevent the effect known as "pumping."

As heretofore constructed the lamp was liable to injury in case the carbon-holders C were too forcibly pulled downward. A careless or unskilled trimmer would frequently hasten the descent of the ratchet in trimming by pulling down on it instead of waiting for it to feed downwardly. In so doing a heavy strain was thrown upon the pinion and delicate wheels of the feeding-train, and they were liable to be injured. Furthermore, by reason of the feeding-train being mounted in a box or cage carried by the armature-lever and having a parallel motion, this downward pull had a tendency to crowd the pinion forcibly into the rack-teeth and derange the parallel-motion device, so that the carbon-holder would either become jammed or would work with undue friction, thereby deranging the operation of the lamp. These difficulties are removed in my present lamp by means of two features of construction. Of these the first consists in the mounting of the spindle *b* of the feeding-pinion *c* directly on the lever E, its journals turning in bearings therein, which are provided at an invariable distance from the fulcrum of the lever, so that the downward pull upon the carbon-holder has no tendency to thrust the pinion into the rack-teeth. The movement of the pinion due to the vibration of the lever is a movement in a very slight arc, and by reason of the fact that the pinion is mounted in the same horizontal line as the fulcrum-axis this arc extends in a direction so nearly approximating a vertical line that the movement of the pinion toward and from the rack is insignificant and involves a less degree of looseness than the usual play necessarily allowed for free intermeshing. There is hence no possibility of the pinion being jammed or crowded into the rack by any downward pull thereon.

The second and novel feature of construction consists in the provision of a frictional connection between the pinion and the remaining portion of the train D, or at least between the pinion and the retarding escapement-wheel *h'*. This frictional connection is best shown in Figs. 10 and 11. Referring to these figures, the pinion *c* is fixed on the spindle *b* by a cross-pin, and the ratchet-wheel *j* is also fixed on this spindle, so that the pinion and the ratchet-wheel are connected fixedly together.

The usual ratchet-pawls *j' j'* are pivoted to a disk *k'*, which is loose on the spindle, but which is necessarily turned with the pinion when the latter moves in the direction of descent of the carbon-holder; but when the pinion is turned in the opposite direction by the lifting movement of the carbon-holder (as is done before inserting a new carbon) the pawls yield and permit the disk *k'* to remain stationary. In frictional contact with this disk is the gear-wheel *l*, by which connection is made with the remaining part of the feeding-train, and this wheel is pressed frictionally against the disk *k'* by a spring *k*, constructed, preferably, in the form of a disk or washer having four or other number of elastic arms pressing toward the wheel *l*, and which is preferably made fast to a flange k^2, connected to the pinion or spindle, so as to turn therewith, whereby the wheel *l* is grasped frictionally between the disk *k'* and spring or washer *k*, both of which are compelled to turn with the pinion when the carbon-holder C is descending. If the carbon-holder be forcibly pulled down, the pinion *c*, ratchet-wheel *j*, disk *k'*, and washer *k* will be caused to revolve; but the wheel *l*, by reason of the resistance of the train, will be kept from revolving faster than the train is permitted to turn by its escapement-governor. The wheel *l* then will remain relatively stationary, while the disk *k'* and spring *k* revolve on opposite sides of it. The frictional engagement between these parts and the wheel *l* is more than sufficient to maintain the carbon-holder elevated, the frictional clutch thus formed yielding only when the carbon-holder is forcibly pulled down. This friction-clutch as a whole is designated by the letter K.

I will now describe the "relighting cut-out." The object of such a cut-out is, in case the lamp becomes extinguished by the arc being blown out by the wind or by either of the carbon pencils breaking off, to temporarily short-circuit the lamp until the feeding mechanism has brought the carbons together again, and thereupon to restore the normal circuit, so that the lamp shall automatically relight itself.

My present invention provides an improved construction of the general form of relighting cut-out claimed in my patent, No. 384,817, above referred to. The armature F, although pivotally connected to the armature-lever E, is nevertheless so mounted as to be capable of a movement beyond that of the lever. When the lever has been tilted to the position shown in Fig. 4, it is stopped by the striking of two legs or toes l' against the top of the shunt-magnet H. The armature F is formed with pivot-pins m m on its opposite ends, connected to the lever E by resting in notches m' m', as best shown in Fig. 3. These notches open downwardly, so that after the lever E is drawn down until stopped by its toes l', if the attraction of the magnet still further increases, it may draw the armature down still lower, thereby pulling its pivot-pins m partially out of the notches m', as shown in dotted lines in Fig. 4. Normally the armature is held up with its pivot-pins in the notches by the attraction of the main magnet, assisted, preferably by a spring n, which is not strong enough to sustain the weight of the armature. This spring is best applied in the form of a flat leaf, as shown in Figs. 5 and 6, with its middle part fastened by a screw n' to the top of the cross-bar of the armature and its opposite ends overhanging and pressing downwardly upon the lever E, as best shown in Fig. 3. This spring might, however, be omitted. It is by means of this independent motion of the armature that the cut-out is operated.

The cut-out contacts, lettered, respectively, L and L′, are carried by the armature F and lever E, respectively. They are preferably made of strips of copper, the contact L being fastened to the armature by the screw n' and extending upwardly and overhanging the contact L′, as shown in Fig. 3. The latter contact consists of a strip of copper fastened to, but insulated from, the rear end of the armature-lever F, as shown in Figs. 5 and 6, and connected by a wire n^2 to the cut-out shunt-circuit M. This cut-out shunt-circuit includes resistance-coils N, wound on asbestus, as described in my said previous patent.

In the normal operation of the lamp the contact L stands well above the contact L′, as shown in Fig. 3. If, however, the arc is blown out or otherwise extinguished, the current through the shunt-coils H will be greatly augmented, thereby strongly exciting the shunt-magnet and drawing down the armature F and lever E until the latter is stopped by its toes l', and drawing down the armature still farther until it is stopped by the abutment of the contact L against the contact L′, as shown in Fig. 4. As soon as these contacts touch the shunt becomes closed and the entire current is short-circuited from the carbons and main magnet (which are in series, as usual) and divides between the shunt-magnet and the cut-out shunt M. The interruption of the circuit and extinguishment of other lamps are thus prevented. As soon as the regulating mechanism has brought the carbons together again the circuit through the carbons and main magnet is re-established, and since this circuit is of low resistance a considerable portion of the current will flow through the main magnet, thereby energizing it and causing it to lift the armature, whereby the contacts L L′ are separated and the lever E is tilted upwardly, thereby lifting the carbon-holder and drawing out the arc again, whereupon the lamp resumes its normal operation. The cut-out shunt M is of only sufficient resistance to insure the diversion through the main magnet, when the carbons come together, of a current strong enough to cause this magnet to act and separate the cut-out contacts, in order to relight the lamp.

In my previous construction of lamp a spring was employed to act upon the armature and react upon the armature-lever, so as to tend to draw the cut-out contacts together, and the main magnet in the normal operation of the lamp held the cut-out contacts apart against the tension of this spring. When the arc was extinguished or an abnormal arc occurred, the abnormal excitation of the shunt-magnet, added to the tension of this spring, drew the cut-out contacts together, and thereupon, the current being shunted through the cut-out circuit M, and the shunt-magnet thereby short-circuited and greatly weakened, the cut-out spring referred to was relied upon to hold the cut-out contacts together. This spring would sometimes become weakened or relaxed by the heat within the mechanism case, and the weight of the armature, which in my previous lamp tended to separate the cut-out contacts, would become effective to draw them slightly apart, so that an arc would form between them, thereby burning or melting them. By my present invention I employ no cut-out spring whatever—that is to say, no spring tending to hold the cut-out contacts together—and consequently there is no tendency to separate them by reason of heat occurring within the mechanism case. Furthermore, the weight of the armature F is so disposed that it tends to draw the contacts together instead of to separate them. The spring n, which is employed to partially overcome this weight, is so arranged that it tends to separate the cut-out contacts instead of to press them together, and consequently if this spring should be relaxed by the heat no separation of the cut-out contacts could occur as a result thereof, because the relaxing of this spring would have the opposite tendency—that is to say, it would permit the attraction of the shunt-magnet to draw the contacts more firmly together. Thus my invention overcomes a difficulty which heretofore occasioned frequently serious injury to the lamps.

I will now describe the "final cut-out," by which the lamp is automatically short-circuited when the carbons are fully burned out. Within the mechanism case I provide a contact spring or arm O, which is electrically connected to the negative binding-post and projects at its free end nearly into contact with the positive-carbon holder C, as shown in Figs. 8 and 9. The positive-carbon holder is provided with a pin o', which when the carbon-holder reaches its lowest position descends against and presses slightly down the spring O, as shown in Fig. 8. The current then passes from the carbon-holder C through this pin into the spring to the negative binding-post, thereby short-circuiting the lamp.

The "hand-switch" or cut-out, by which the lamp may be switched into or out of circuit by hand, is constructed very much as in my previous patents. It has a handle P at the bottom of the mechanism case, connected to a vertical shaft or spindle p, extending up through the case and serving as the support for the resistance-coils N, and having fixed to its upper end a switch-arm p', which can be turned into contact with an elastic-metal seat P′. This seat is fastened to the inner roof-plate Q, which is of metal and in connection, as heretofore, with the positive binding-post. The upper end of the shaft p is mounted to turn in a recess in the lower end of the negative binding-post R′, as shown in Fig. 7, whereby the switch-arm p' is in electrical connection with the negative binding-post.

The positive binding-post R (shown in section in Fig. 5) is in metallic connection with the inner roof-plate Q, while the negative binding-post R′ is insulated therefrom, as shown in Figs. 7 and 8. These binding-posts are constructed with suspension-hooks r r, as heretofore, and these hooks are arranged with their bent portions in the same vertical plane as the center of the looped frame B, as heretofore. Instead, however, of arranging the binding-posts with their centers in this same plane and directly under the bends of their hooks, the binding-posts are arranged to one side of this plane, so that they are out of line with the hooks and so that the connecting line-wires are brought behind the hooks and their interference or entanglement with the hooks and with the suspension-loops of the hanger-board is thereby avoided.

The mechanism-case is constructed of an exterior portion which is insulated from the circuit and of an inner portion or frame which is in electric connection with the positive binding-post. This inner portion or frame is composed of the inner roof-plate Q at the top, of a base plate or disk S at the bottom, and of three intervening vertical frames consisting of the two frames e' e', before referred to, and a third frame e^2 at the rear of the case, these three frames extending between the upper and lower plates and fastened to them by screws. The carbon-holder C slides through holes in the centers of the upper and lower plates Q and S, being guided thereby, as usual. The current is conducted to this carbon-holder through these plates and through the usual copper springs a'. Beneath the bottom plate S is fastened a disk F′, of insulating material, the periphery of which projects beyond that of the plate S. The mechanism is inclosed and concealed by a tubular shell q, of sheet metal, the lower portion of which extends close outside of and somewhat below the insulating-disk F′, so that it is held in place by the latter. The upper end of this shell enters within a pendent flange q', formed on the outer top plate Q′, and is held in position thereby. To get access to the interior mechanism, this outer shell q is dropped down onto the lower frame B. When pushed up into place, it is held there by two leaf-spring catches q^2 q^2, which take over the insulation F′ without touching the metal plate S. Their ends project downward sufficiently to be easily reached and pressed out by the fingers when it is desired to unfasten and drop down the shell. The upper plate Q′ is insulated from the lower top plate Q by two insulating plates or washers r^2, through which the respective binding-posts pass, the plates being mechanically fastened together by these binding-posts, which are constructed to serve as fastening-bolts in the same manner as heretofore.

The plate Q is of considerably-smaller diameter than the shell q, so that it remains out of contact with the latter, and is thereby insulated therefrom. The purpose of thus insulating the exterior portions Q′ and q of the mechanism-case is to prevent the possibility of the trimmer receiving a shock therefrom. I also provide for insulating the lower frame B for the same purpose. This frame consists, preferably, of a single casting, the opposite arms of which terminate at their upper ends in two horizontal plates or cross-heads s', connected by a cross-bar s^2. These cross-heads s' are fastened against the bottom of the insulating-plate F′ by screws which are passed through them, but insulated from them, and which screw into the plate S.

The electric connection with the negative-carbon holder C′ is made through the medium of an insulated wire t, which is connected within the mechanism-case with the end of the main-magnet coil G by a binding-ring t', as shown in Fig. 3, and extends thence downwardly through the bottom of the mechanism case, being insulated therefrom by an insulating-bushing t^2, and is carried down along one side of the frame B, in the manner shown best in Fig. 1, being fastened thereto at intervals by small pins u' u', driven into holes in the frame and their ends bent down over the wire, so as to embrace it. This fastening is claimed in my patent, No. 407,914, dated July 30, 1889. The lower end of the wire is carried within the globe-holder B′, as shown in Fig. 12, and its end is connected in the ordinary manner to the insulated negative conductor C′.

The ash-cup T, which is commonly placed beneath the lower-carbon holder to catch the carbon dust or ashes that falls from the carbons, is fastened to the globe-holder B′ by a sort of bayonet-joint, so constructed, however, that the ash-cup is less liable than heretofore to come loose and drop out. The ash-cup is constructed with a flange u, as usual, and this flange has notches v formed in it. These notches register with lugs v', projecting inwardly from the lower part of the globe-holder B′, as shown in Fig. 13. To fasten on the ash-cup, it is thrust up beneath the globe-holder and turned until these notches coincide with the lugs. It is then pushed up to bring its flange above the lugs, and it is then turned toward the right until its ribs u^2 strike the lugs and stop it. One of the lugs is shown in dotted lines at v' in Fig. 15. The flange u is formed with beveled teeth u^3 on its under side, which present their abrupt faces toward the lugs v' when the ash-cup is in place, as shown best in Fig. 15. If the jarring of the lamp should tend to rotate the ash-cup in a direction to disengage it, the abrupt faces of these teeth would abut against the lugs and would prevent further rotation, whereby the ash-cup is retained securely in place.

The carbon-clamp U, applied to the carbon-holder C for clamping the positive carbon thereto, is of novel construction. It consists, as shown best in Figs. 4 and 5, of a carbon-gripping device of any usual construction, carried by a sleeve or hub w, which is swiveled on the lower end of the carbon-holding rod C, the axis of the sleeve w being out of line with the axis of the carbon pencil, which is fastened in the gripping device. By reason of this eccentricity or want of alignment the rotation of the carbon-clamp on the rod C will cause the lower end of the positive carbon to describe a circle; hence, if the points of two carbon pencils do not come into line one above the other, the positive-carbon clamp may be turned in either direction to bring its carbon into correct alignment with the negative carbon. The sleeve w is fastened on the rod C, so that it cannot fall off therefrom, by means of a screw or pin w', the end of which enters an annular groove formed around the rod C. A set-screw w^2 is provided for clamping the sleeve fast on the carbon-holder when the carbons have been brought to the correct position. This construction of carbon-clamp is much simpler than the adjustable clamps heretofore used, which are hung to the carbon-holder rod by a ball-and-socket connection and have three adjusting-screws for adjusting the clamp to different angles relatively to the rod. With that construction, if either one of these screws is left loose the upper carbon is liable to be displaced laterally and to slip down past the lower carbon, thereby deranging the operation of the lamp.

I will now describe the construction of the duplex lamp with reference to Fig. 2 and Figs. 16 to 21. This lamp contains the same mechanism as the single lamp, with only the addition of certain parts designed to hold the second carbon-holder out of action during the feeding of the first carbon and upon the consumption of the first carbon to throw the second carbon into feed. The mechanism is rearranged in some respects to adapt it for engagement with two carbon-holders in place of one.

The two positive-carbon holders C are distinguished by being designated C′ and C², C′ being the carbon-holder of the carbon which burns first, and C² of the one which burns second. These carbon-holders extend through the mechanism case on opposite sides of the center thereof, as is usual in duplex lamps, their upper ends working in protecting-tubes a' and a^2, respectively.

The rack-teeth of the carbon-holders engage pinions c' and c^2, respectively, which are carried on the feeding-spindle b, but turn loosely thereon, being connected to it only through the medium of the usual ratchet-and-pawl connections. The ends of the spindle are hung in arms E′ E′, forming part of the frame of the armature-lever E, which is to this extent modified in shape, and the longitudinal side bars of the rear frame of which are drooped at E² to make room for the spindle b and its attached wheels.

The weight of both the first and second carbon-holders is borne by the armature-lever during all the time that the lamp is in operation. While the first pair of carbons is burning the second carbon-holder C² is suspended from the lever in such manner that it cannot be fed downwardly, while the first carbon-holder C′ is in engagement with the feeding mechanism in the same manner as in a single lamp. When the first pair of carbons is consumed and the first carbon-holder reaches the limit of its downward movement, it automatically disengages the second carbon-holder and enables it to feed down, after which the first carbon-holder hangs inertly suspended from the lever. The lamp is finally cut out by the switch O (shown in Fig. 8) when the second carbon-holder reaches the limit of its downward movement.

The suspension of the second carbon-holder out of action during the time that the first carbon-holder is feeding downward is accomplished by means of a ratchet-wheel x, fastened to the second feeding-pinion c^2, as shown best in Figs. 18 to 21, engaged by a pawl x', pivoted to the armature-lever E and pressed by a spring y^3, so as to engage with the ratchet-wheel. This pawl yields to the rotation of the ratchet-wheel x when the second carbon-holder is pushed up, but thereupon immediately engages, as shown in Fig. 20, and prevents the carbon-holder from feeding down. Meanwhile the feeding of the first carbon-holder proceeds without interruption, the spindle b turning freely within the sleeve or hub of the pinion c^2 and ratchet-wheel x. During the feeding of the first carbon-holder the disk k', carrying the pawls j' of the ratchet-wheel j, rotates with the spindle, and these pawls ride freely over the ratchet-wheel.

In order to throw the second carbon-holder into action, a releasing device is provided for throwing up the pawl x' to the position shown in Fig. 21. This releasing device consists in the preferred construction of a rock-shaft y, mounted in bearings on the lever E, extending from near one carbon-holder to near the other and having two projecting arms or cranks y' and y^2. The arm y' stands normally over the tail of the pawl x', as shown in Fig. 20. The arm y^2 extends close to the first carbon-holder, and stands directly beneath a pin b' thereon. This rock-shaft y is tilted by its arm y', resting on the upper end of the pawl x', which is raised by the action of the flat spring y^3, thereby lifting the arms y' and y^2, the movement being limited by the engagement of the pawl x' with the ratchet-wheel x, as shown in Fig. 20. While the first carbon-holder is feeding the parts stand in the positions shown in Figs. 19 and 20. Finally the pin b' encounters the arm y^2 and tilts the rock-shaft, thereby throwing down the arm y' onto the tail of the pawl x', compressing the spring y^3 and disengaging the pawl from the ratchet-wheel x, as shown in Fig. 21. Thereupon the second carbon-holder C^2 commences to feed downwardly and brings its carbon into contact with the negative carbon beneath, while the arc is still maintained between the first pair of carbons, whereby the arc is transferred to the second pair. The first carbon-holder C′ remains suspended from the lever E by its pin b', resting on the arm y^2.

In order to be able to disengage the pawl x' at will, to enable the trimmer to pull down the second carbon-holder, (thereby making use of the friction-clutch K, before described,) or to enable the second carbon-holder to run down of itself to any position, a pull-knob z is provided underneath the mechanism case, as best shown in Fig. 16, which is connected through a rod z' to an arm y^4, formed on the rock-shaft y, so that by pulling down this knob the rock-shaft may be tilted to the same effect as by the pin b', thereby disengaging the pawl x'.

In order to prevent the second carbon-holder being pushed up so high as to bring its carbon-clamp U close against the under side of the mechanism case, and thereby to resist and prevent the lifting of the carbon-holder in order to strike the arc, I provide a lever z^2, (shown in Fig. 16,) which, when the second carbon-holder is thrust fully up, will be engaged and thrust back by its carbon-clamp U, so that its lower arm will be vibrated downwardly and will press down the knob z, and thereby disengage the pawl x'. When the second carbon-holder is let go, it will feed downwardly until it releases the lever z^2—that is, until it reaches the position shown in Fig. 16—whereupon the knob z being released, the pawl x' will fall into engagement and prevent its further descent. The second carbon-clamp U is then sufficiently below the bottom plate of the case to admit of the upward play of the carbon-holders in order to strike the arc.

The second carbon-holder may be set originally at any desired height in my lamp. In other duplex lamps the second carbon-holder must be suspended in its uppermost position during the operation of the first carbon-holder.

In the operation of duplex lamps it does not always occur that both pairs of carbons are completely consumed, it being frequently the case that the lamps are required to burn only long enough to consume the first pair and about half of the second pair. In such a case it is desirable to utilize the remainder of the second pair on the ensuing night; but to do this heretofore it has been necessary for the trimmer to remove the partially-burned carbons of the second pair and transfer them to the first carbon-holders and to put full-length carbons into the second carbon-holders; otherwise the light is extinguished for a moment after the first carbons are consumed. This trouble is avoided by my invention, which enables the partially-consumed carbons to be left in the second carbon-holders and requires only that the first carbon-holders be supplied with new carbons.

Another advantage of my present invention is that it makes no difference which pair of carbons lights first, so that less care is required in trimming the lamp. If the arc first springs between the second pair of carbons, it will burn without feeding until the first carbon-holder feeds down and brings the carbons of the first pair into contact; whereupon the arc will be transferred to the first pair of carbons.

My improved duplex lamp is also an improvement upon my previous duplex lamp, in that it makes no difference which of the carbon-holders was lifted last. With my previous lamp the trimmer had to be careful to lift the first carbon-holder last, as otherwise the lamp would be inoperative; but with my present lamp no carelessness on the part of the trimmer, short of an injury to the lamp mechanism or an improper setting of the carbon-pencils themselves, can render the lamp inoperative.

My improved duplex lamp may be modified by omitting the ratchet-wheel x and applying the pawl directly to the teeth of the pinion c^2 to like effect; or, the pawl may be made to engage the teeth of the rack on the holder C^2 instead. In these cases the pinion or rack will become the equivalent of the ratchet-wheel x. The disengaging device might be a simple lever of the first class instead of the rock-shaft y. The disengaging device might be mounted on any other or stationary part instead of on the lever E, but with less advantage. The mechanism may be otherwise modified, as may be readily inferred by those skilled in the art.

In both the single and duplex lamps the two members of the looped frame B and the annular globe-holder B′, with its cross-bars for supporting the central hub, to which the negative-carbon holder is fastened, are all cast in one piece. This I believe to be a novel construction in electric lamps having looped frames, it having been customary heretofore to make the globe-holder separate from the members of the frame and to fasten it thereto by screws.

I claim as my invention the following defined novel features and combinations, substantially as hereinbefore specified, namely:

1. The combination, with a carbon-holder having rack-teeth, an armature-lever, a feeding-train carried by said lever, terminating in a pinion meshing with said rack and having a toothed stop-wheel, and a stationary stop-tooth arranged to engage said stop-wheel when the latter is moved toward it by the lever, of an elastic arm or spring on which said tooth is formed or mounted, extending approximately horizontally, bent at right angles, and fastened, and an adjusting-screw arranged horizontally to bear against said elastic arm, whereby by the horizontal adjustment of said screw the stop-tooth may be raised or lowered, and thereby adjusted relatively to the stop-wheel.

2. In an arc lamp, the combination, with a carbon-holder having rack-teeth and a feeding-train for feeding down the holder, including a feeding-pinion engaging with the rack and a retarding device for governing the rate of feed, of a friction-clutch interposed between said pinion and retarding device, whereby when the carbon-holder is forcibly pulled down the said clutch will slip and avoid injury to the feeding-train.

3. In an arc lamp, the combination, with a carbon-holder having rack-teeth and a feeding-train, including a feeding-pinion, engaging said rack, and a retarding device, of a friction-clutch consisting of a gear-wheel on said train, connected through its gear-teeth with the retarding device, a disk connected to the feeding-pinion, so as to rotate therewith when the carbon-holder descends, and a spring for pressing said gear-wheel and disk into frictional contact.

4. In an arc lamp, the combination of an armature-lever, a main magnet above the lever and a shunt-magnet below it, an interposed armature connected to the lever through a loose pivotal connection adapted to permit of the armature being drawn down by the shunt-magnet independently of the lever, and cut-out contacts carried by the lever and armature, respectively, the one carried by the armature being arranged over and standing normally out of contact with the one carried by the lever, whereby an abnormal excitation of the shunt-magnet draws down the armature and brings said contacts together and the weight of the armature tends to hold them together.

5. In an arc lamp, the combination of an armature-lever, a main magnet above the lever and a shunt-magnet below it, an interposed armature connected to the lever through a loose pivotal connection adapted to permit of the armature being drawn down by the shunt-magnet independently of the lever, a spring tending to lift the armature and reacting against the armature-lever, and a cut-out contact carried by the armature and lever, respectively, and arranged to be closed together by the attraction of the armature downwardly relatively to the lever and against the tension of said spring, whereby the weakening of said spring by heat will have no tendency to separate the cut-out contacts.

6. In an arc lamp, the combination of an armature-lever, a main magnet above the lever and a shunt-magnet below it, an interposed armature connected to the lever through a loose pivotal connection adapted to permit of the armature being drawn down by the shunt-magnet independently of the lever, stops for limiting the drawing down of the lever, and cut-out contacts carried by the lever and armature, respectively, that carried by the armature standing over the one carried by the lever and arranged when brought together by the attraction of the armature by an abnormal excitation of the shunt-magnet to form stops for limiting the downward movement of the armature.

7. In an arc lamp, the combination, with an armature F and an armature-lever E, constructed as an annular frame to inclose the armature and having notches open beneath engaged by pivot-pins on the armature, of a spring *n*, for partly sustaining the weight of the armature, consisting of a leaf fastened to the armature at its middle and having its free ends pressing downwardly on opposite sides of the lever.

8. In an arc lamp, the combination, with the mechanism-case, the negative binding-post passing through and insulated from the top of the case, and the positive-carbon holder C, having a pin *o′* projecting from it near its upper end, of a spring cut-out arm O, fastened to and in electric connection with the negative binding-post underneath the top of the case, and arranged with its free end projecting into the path of said pin *o′* in position to be encountered thereby when the carbon-holder reaches the end of its downward movement, and thereby to stop the latter yieldingly and short-circuit the lamp.

9. In an arc lamp having a mechanism-case and a frame extending thence downwardly for the support of the lower-carbon holder, the positive and negative binding-posts constructed with suspension-hooks arranged with their bends in the same plane as said lower frame, and the binding-posts displaced from

said plane to the rear of the hooks, for the purpose specified.

10. In an electric lamp, the combination, with the globe-holder having projecting lugs, of an ash-cup having a notched flange for engaging said lugs, formed with beveled teeth, the abrupt faces of which are arranged to be presented to the lugs when the ash-cup is in place.

11. In an arc lamp, the combination, with a carbon-holding rod, of a carbon-clamp having gripping-jaws for engaging the carbon pencil arranged to hold the latter with its axis out of line with the axis of the rod and connected to the rod through the medium of a swivel-connection, whereby it may be rotated relatively to the rod.

12. In an arc lamp, the combination, with a carbon-holding rod, of a carbon-clamp consisting of gripping-jaws arranged to hold the latter with its axis eccentric to that of the rod and connected to the rod through the medium of a swiveled connection, whereby the carbon-clamp may be turned relatively to the rod, and with a set-screw for fastening it in any rotative position.

13. In a duplex lamp, the combination of the carbon-holders having rack-teeth, feeding-pinions engaging therewith, an armature-lever carrying said pinions, a feeding-train for regulating the feed, a pawl carried by the armature-lever and adapted to prevent the feeding down of the second carbon-holder during the feeding of the first holder, and a projection carried by the first carbon-holder and adapted at the termination of the movement thereof to throw said pawl out of action and cause the second carbon-holder to feed.

14. In a duplex arc lamp, the combination, with the two carbon-holders having rack-teeth, of two feeding-pinions, an armature-lever carrying said pinions, a ratchet-wheel connected to the second feeding-pinion, and a pawl adapted to engage said wheel during the feeding down of the first carbon-holder, and thereby prevent the rotation of the second feeding-pinion.

15. In a duplex arc lamp, the combination, with two carbon-holders having rack-teeth, of two feeding-pinions, an armature-lever carrying them, a ratchet-wheel connected to the second feeding-pinion, a pawl adapted to engage said ratchet-wheel to prevent the rotation of the second feeding-pinion during the feeding down of the first carbon-holder, a stop projection on the first carbon-holder, and a mechanical connection between said stop projection and pawl, adapted upon the termination of the downward movement of the first carbon-holder to communicate motion to said pawl and withdraw it from said ratchet-wheel.

16. In a duplex arc lamp, the combination of the two carbon-holders having rack-teeth, two feeding-pinions engaging said racks, an armature-lever carrying said pinions, a ratchet-and-pawl device adapted to normally prevent the feeding of the second carbon-holder, a rock-shaft having an arm adapted when rocked to disengage said pawl, and the first carbon-holder having a stop projection arranged when it reaches the limit of its downward movement to encounter said rock-shaft and oscillate it in a direction to release said pawl.

17. In a duplex arc lamp, the combination of the two carbon-holders having rack-teeth, two feeding-pinions engaging said racks, an armature-lever carrying said pinions, a ratchet-and-pawl device adapted to normally prevent the feeding of the second carbon-holder, a rock-shaft having an arm adapted when rocked to disengage said pawl, and the first carbon-holder having a stop projection arranged when it reaches the limit of its downward movement to encounter said rock-shaft and oscillate it in a direction to release said pawl, and means for releasing said pawl by hand, consisting of a knob beneath the mechanism-case, and a mechanical connection between said knob and the rock-shaft, whereby the shaft may be oscillated from said knob.

18. In a duplex arc lamp, the combination, with the carbon-holders having rack-teeth, of feeding-pinions engaging them, a ratchet-and-pawl device adapted to normally prevent the feeding of the second carbon-holder, means, substantially as described, for releasing said pawl when the first carbon-holder reaches the limit of its feeding movement, and a mechanical connection operated by the lifting of the second carbon-holder to its extreme height to release said pawl and hold it released until the second carbon-holder is dropped sufficiently to admit of the striking of the arc.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JAMES J. WOOD.

Witnesses:
GEORGE H. FRASER,
CHARLES K. FRASER.