No. 662,996. Patented Dec. 4, 1900.

J. J. WOOD.

ELECTRIC ARC LAMP.

(Application filed Dec. 4, 1899.)

(No Model.) 7 Sheets—Sheet 1.

FIG. 1.

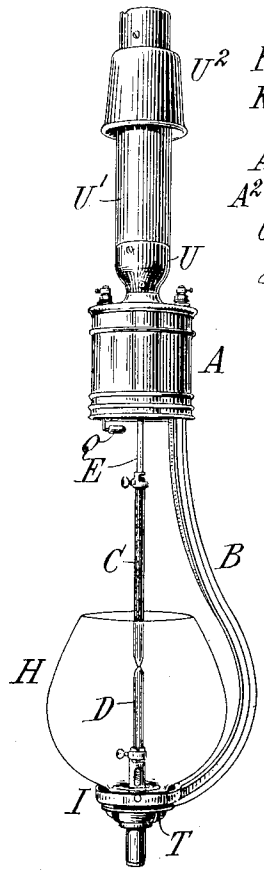


FIG. 2.

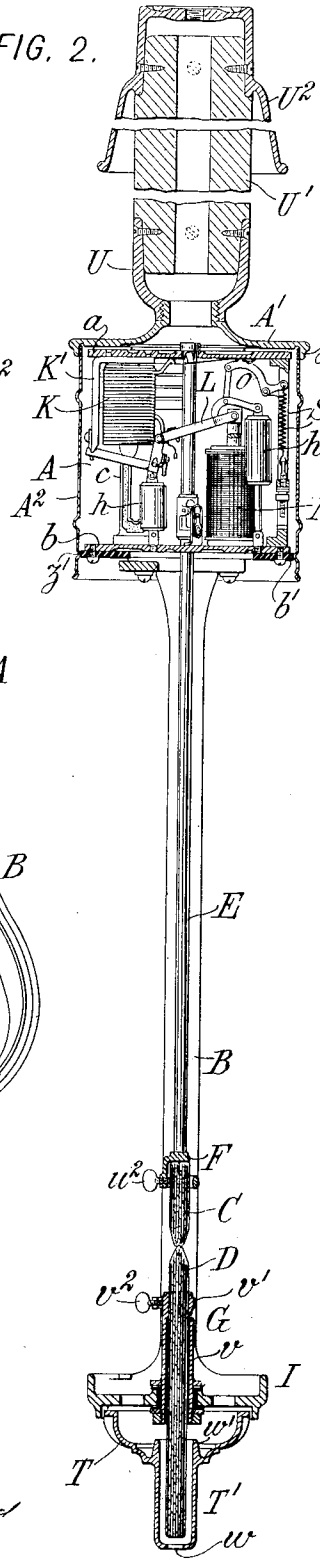
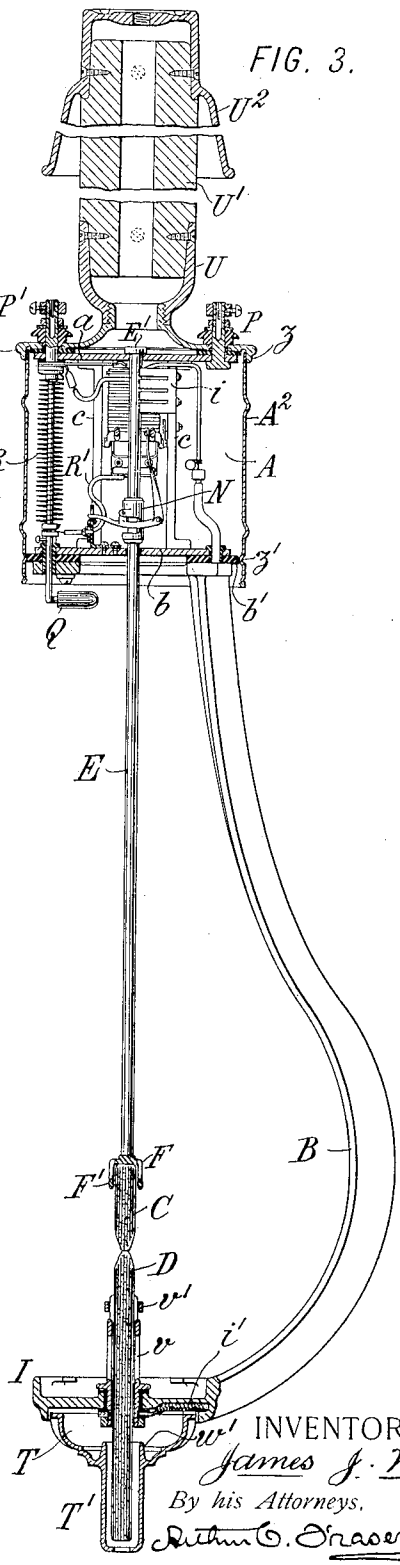


FIG. 3.



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FIG. 4.

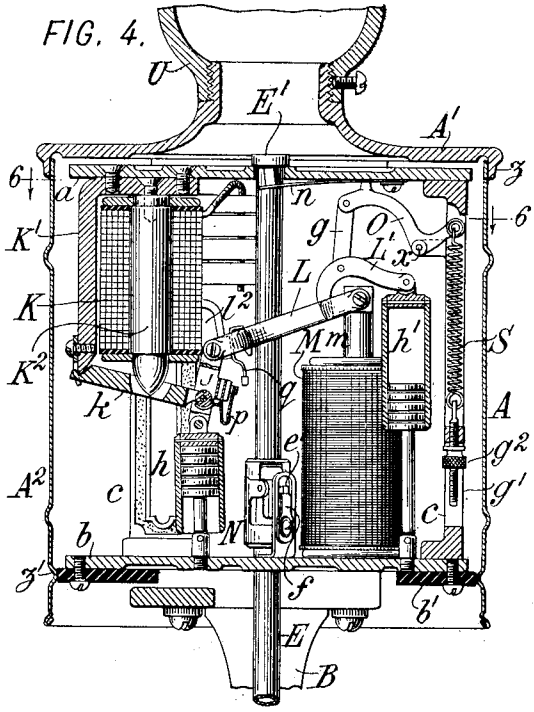


FIG. 5.

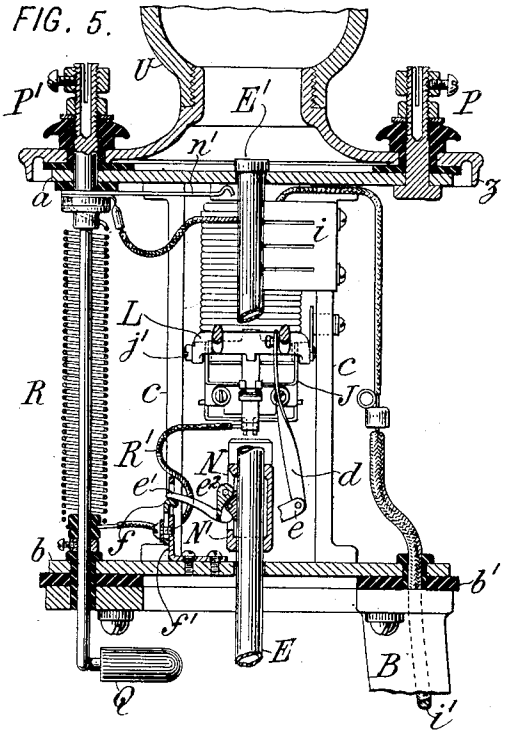


FIG. 7.

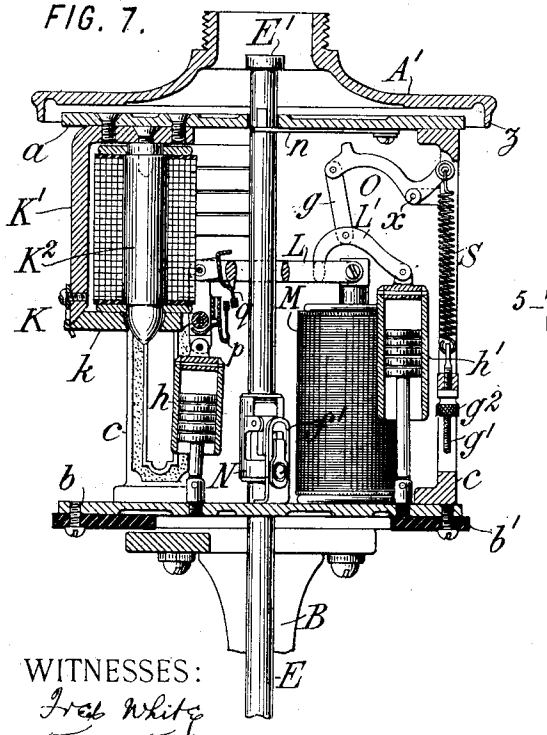
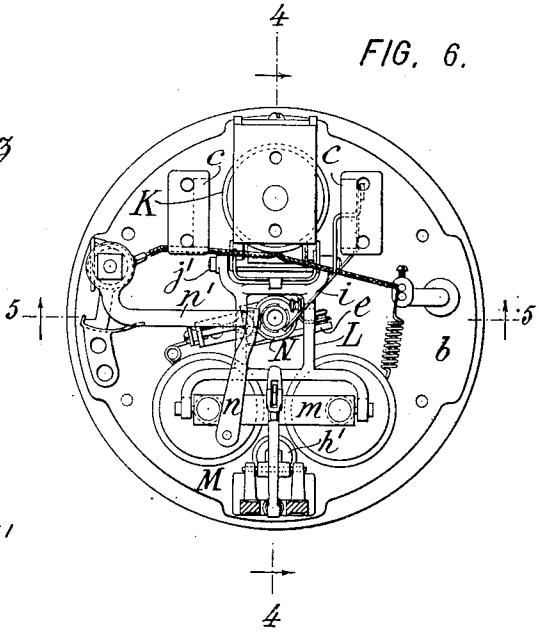


FIG. 6.



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FIG. 8.

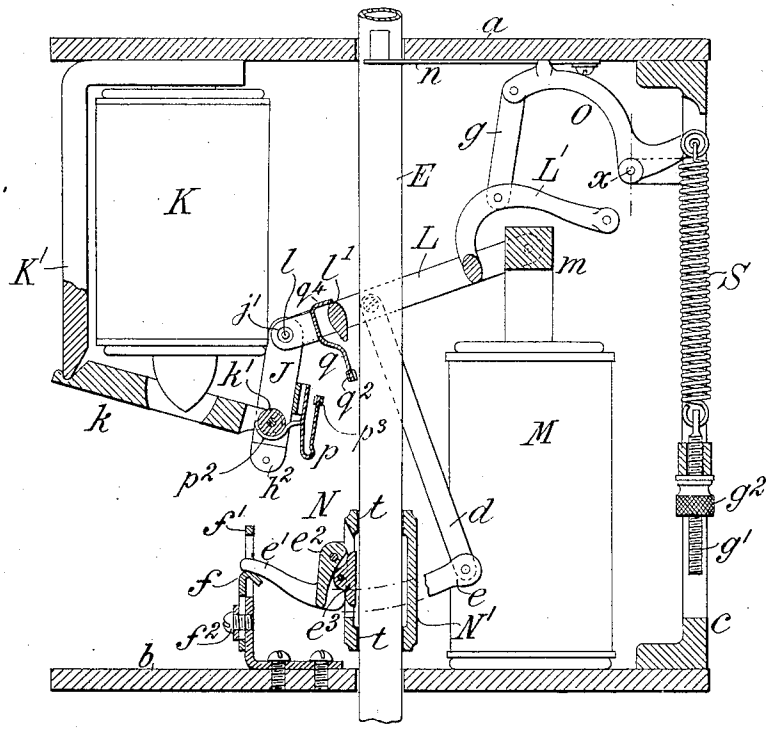
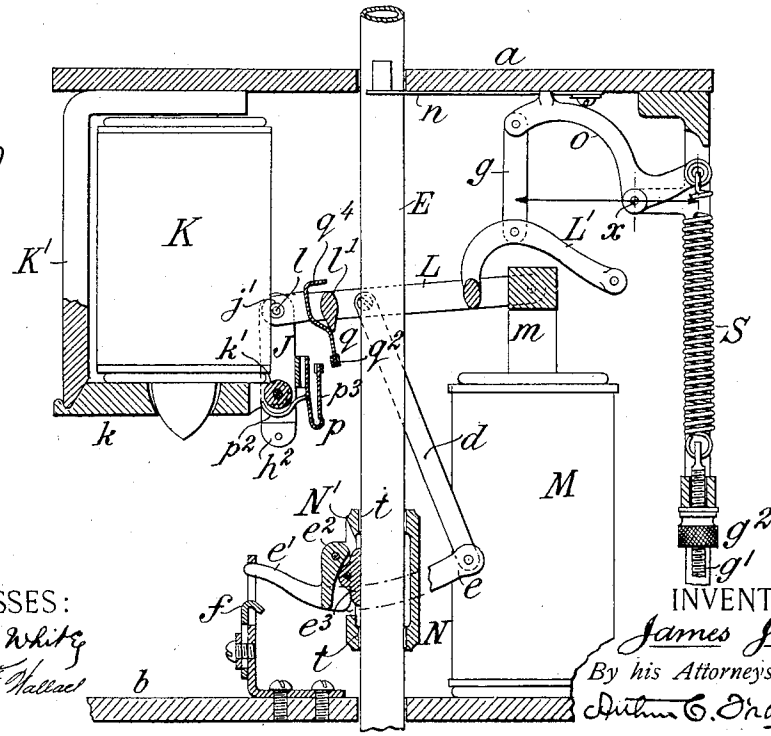


FIG. 9.



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(No Model.) 7 Sheets—Sheet 4.

FIG. 10.

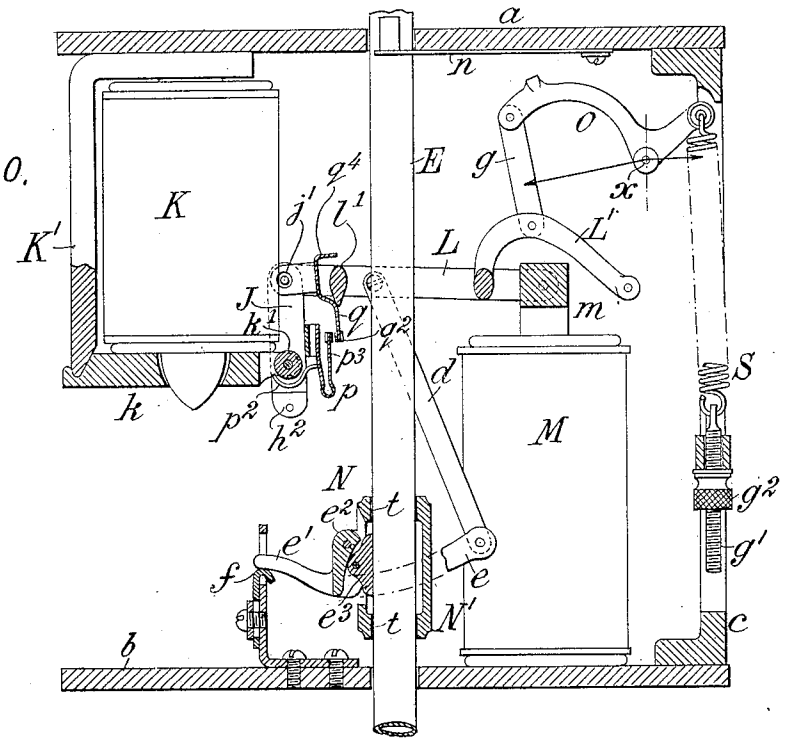
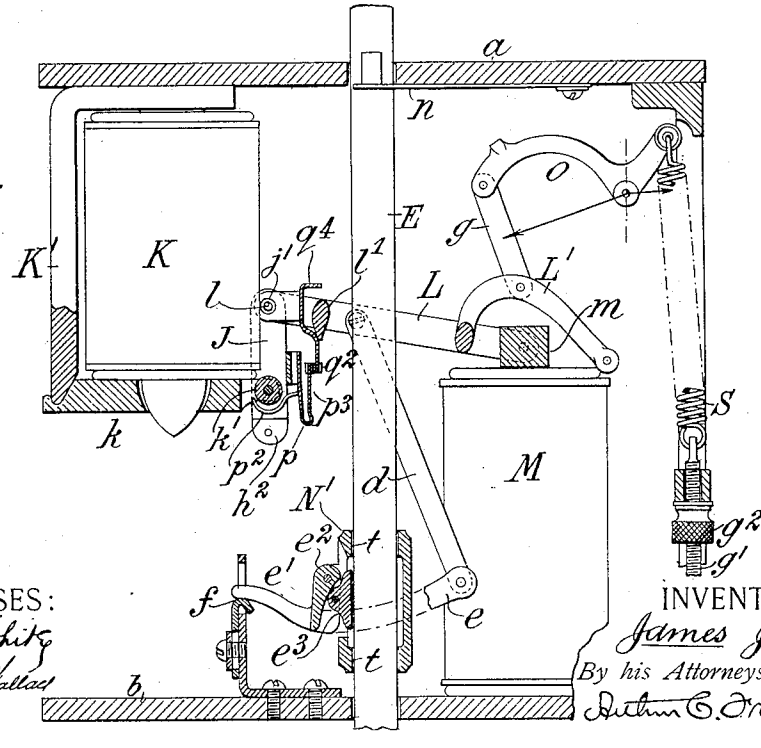


FIG. 11.



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(Application filed Dec. 4, 1899.)

(No Model.) 7 Sheets—Sheet 5.

FIG. 12.

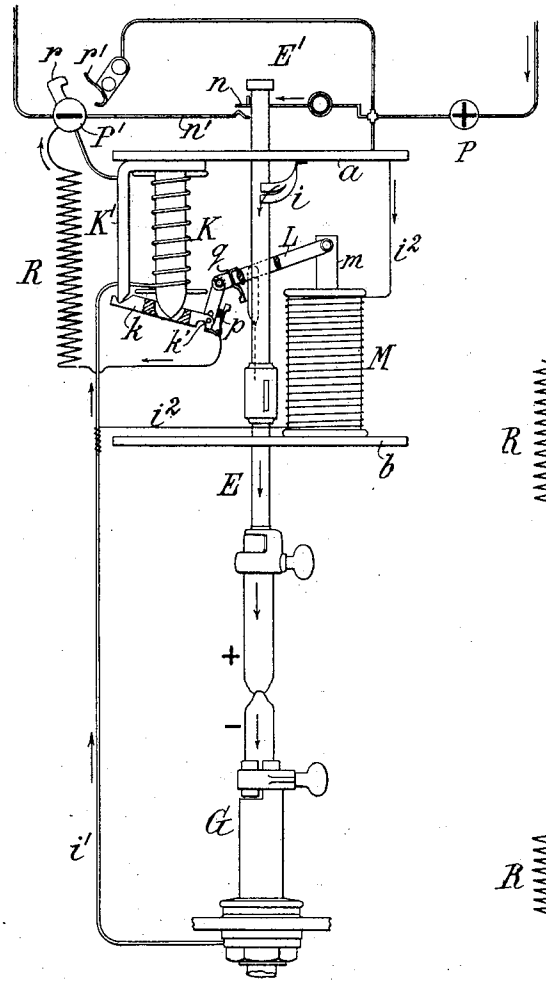


FIG. 39.

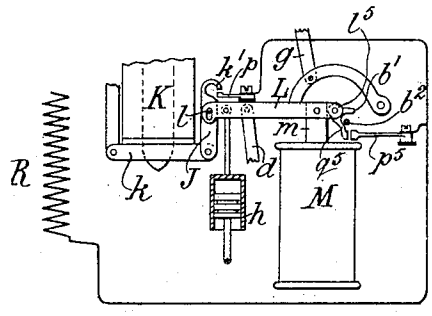
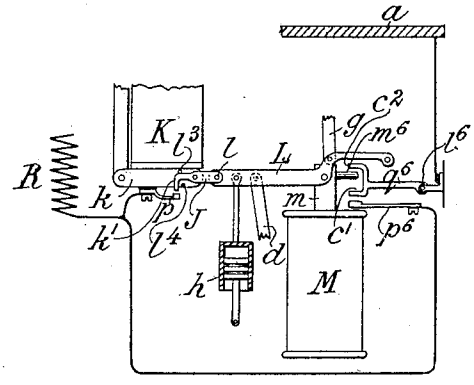


FIG. 40.



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J. J. WOOD.

ELECTRIC ARC LAMP.

(Application filed Dec. 4, 1899.)

(No Model.) 7 Sheets—Sheet 6.

FIG. 13.

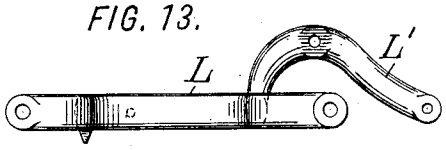


FIG. 14.

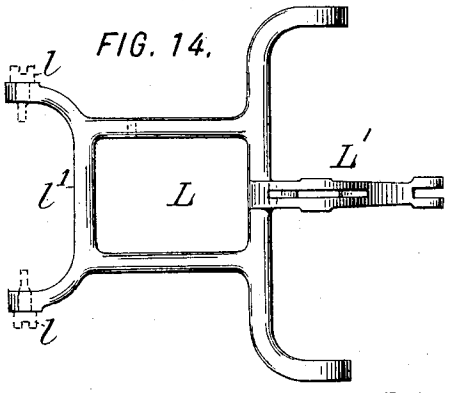


FIG. 15

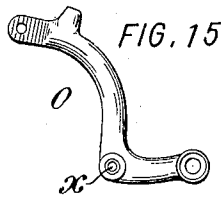


FIG. 16.

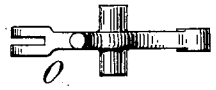


FIG. 17. FIG. 18.

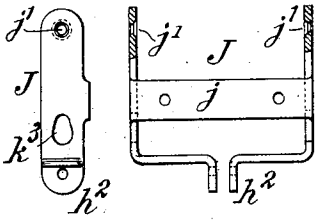


FIG. 19.

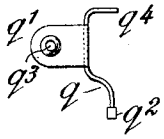


FIG. 20.

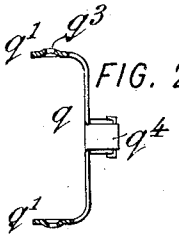


FIG. 23.

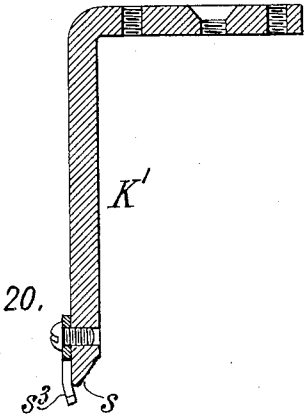


FIG. 24.

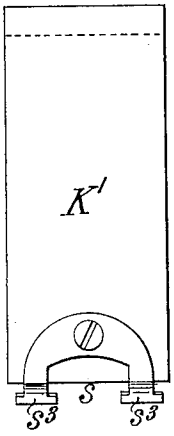


FIG. 21 FIG. 22.



FIG. 25.

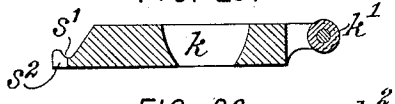


FIG. 26.

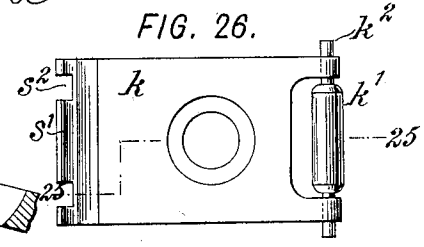


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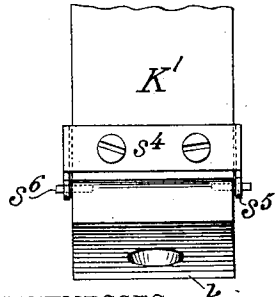
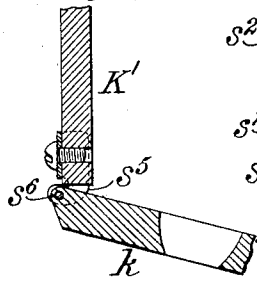


FIG. 28.



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No. 662,996. Patented Dec. 4, 1900.

J. J. WOOD.

ELECTRIC ARC LAMP.

(Application filed Dec. 4, 1899.)

(No Model.) 7 Sheets—Sheet 7.

FIG. 29.

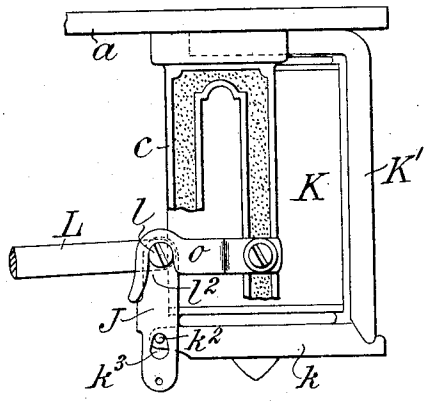


FIG. 30.

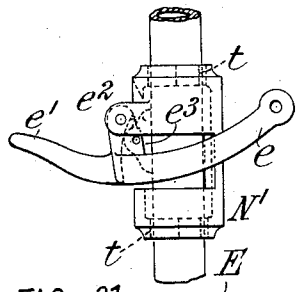


FIG. 31.

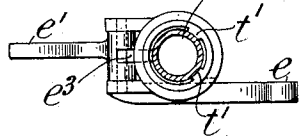


FIG. 34.

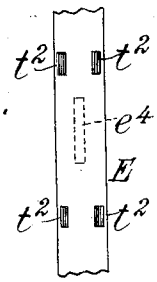


FIG. 35.

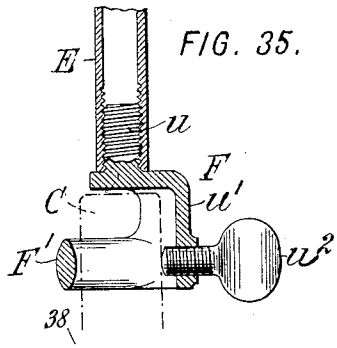


FIG. 36.

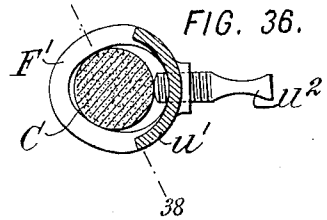


FIG. 37.

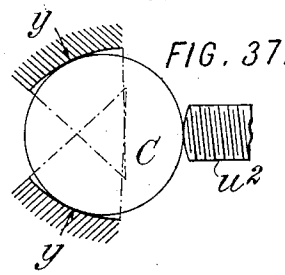


FIG 38.

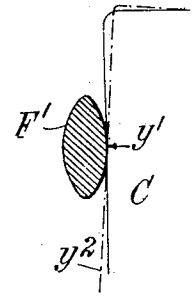


FIG. 32.

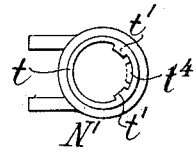
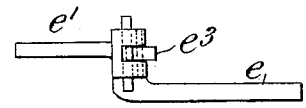


FIG. 33.



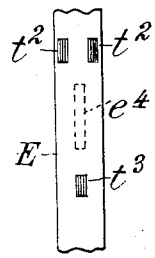


FIG. 34.a

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UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF FORT WAYNE, INDIANA.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 662,996, dated December 4, 1900.

Application filed December 4, 1899. Serial No. 739,111. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. WOOD, a citizen of the United States, residing at Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates chiefly to arc-lamps adapted to be installed serially on a circuit carrying a constant current, but is not confined thereto.

The principal object of the invention is to render the feeding extremely sensitive, in order to maintain the arc of uniform length and to avoid any material fluctuation in the energy expended in the lamp. Ordinary constant-current arc-lamps designed to absorb fifty volts have a range of variation in feeding of from five to ten volts, or even more. By my invention the extreme range is reduced to three volts, and under normal conditions the variation is less than one-fourth of a volt, being so small as to be imperceptible upon a volt-meter.

Another object of the invention is to economize as far as possible the energy necessarily expended to produce and maintain the separation of the carbons.

A further object is to cheapen and simplify the mechanism as far as is consistent with the foregoing conditions and to render its operation as exact and certain as possible under all conditions.

A further object as applied to a clutch-feed lamp is to render the clutch as sensitive as possible in its gripping and releasing action, so that in normal feeding the clutch shall act practically as a friction-brake, through which the feed-rod is almost constantly descending at a rate almost exactly proportioned to the rate of consumption of the carbons.

The invention further provides novel features and details of mechanism, which will be fully hereinafter described.

The accompanying drawings show the preferred embodiment of my invention as applied to a clutch-feed lamp adapted for burning a single pair of carbons of preferably large diameter.

Figure 1 is a perspective view of the lamp on a small scale. Fig. 2 is a vertical mid-section, and Fig. 3 is a similar vertical mid-section viewed at right angles to Fig. 2. Fig. 4 is a vertical section of the lamp mechanism, on a larger scale, viewed from the same direction as Fig. 2, the section being cut on the line 4 4 in Fig. 6, the mechanism being shown in the inert position before turning on the current. Fig. 5 is a view on the same scale as Fig. 4, viewed in the same direction as Fig. 3, the section being on the line 5 5 in Fig. 6. Fig. 6 is a horizontal section on the line 6 6 in Fig. 4, the inclosing case or shell being omitted. Fig. 7 is a section similar to Fig. 4, but showing the mechanism in a different position—namely, in the normal feeding position. Figs. 8, 9, 10, and 11 are sectional elevations, on a larger scale, showing the lamp mechanism in four successive positions. Fig. 12 is a diagrammatic elevation of the main parts of the lamp, showing the circuit connections. Fig. 13 is a side elevation, and Fig. 14 a plan, of the feeding-lever. Fig. 15 is a side elevation, and Fig. 16 a plan, of the retractor. Fig. 17 is a side elevation, and Fig. 18 a front elevation, partly in section, of the bridge-piece or fulcrum lifter connecting the separating armature with the feeding-lever. Fig. 19 is a side elevation, and Fig. 20 a plan, partly in section, of one of the cut-out contacts. Fig. 21 is a side elevation, and Fig. 22 a front elevation, of the other contact. Fig. 23 is a vertical mid-section, and Fig. 24 is a rear elevation, of the iron frame of the separating-magnet. Fig. 25 is a section on the line 25 25 in Fig. 26, and Fig. 26 is a plan, of the separating-magnet armature. Fig. 27 is a rear elevation, and Fig. 28 is a vertical mid-section, of a modification of the separating-magnet frame and armature. Fig. 29 is a fragmentary side elevation of a portion of the lamp mechanism, showing the parts in the same position as in Fig. 7. Figs. 30 to 33 show the improved feeding-clutch, Fig. 30 being a side elevation, Fig. 31 a plan, and Figs. 32 and 33 plans of the clutch barrel and lever, respectively. Fig. 34 is an elevation of the feed-rod, showing the touch-points of the clutch; and Fig. 34[a] is a similar view showing a modified arrangement. Fig. 35 is a vertical section of the positive-carbon holder or clamp. Fig. 36 is a horizontal section thereof. Fig. 37 is an enlarged diagrammatic horizontal

section in the plane of contact. Fig. 38 is a fragmentary vertical section on the line 38 38 in Fig. 36. Figs. 39 and 40 are diagrams illustrating modifications and corresponding to Fig. 12.

In this lamp I employ separate magnets or solenoids for separating the carbons and for feeding. These I will for convenience designate, respectively, as the "separating-magnet" and the "feeding-magnet." The armatures or movable members of these magnets are both connected to a lever, which I will call the "feeding-lever" and which in turn is connected to the feeding device, which is preferably a clutch, in order to communicate to the feed-rod the movements of either armature for the purpose, initially, of lifting the feed-rod to separate the carbons and draw the arc, and subsequently, in the normal operation of the lamp, of controlling the feed of the carbons together to compensate for their consumption. A resistance-coil is provided, arranged as a shunt, short-circuiting both magnets and cut in or out by a contact device operated under certain conditions by either magnet.

Referring to the drawings, let A designate the mechanism-case of the lamp; B, the pendent or drop frame thereof; C and D, the upper and lower or positive and negative carbons, respectively; E, the feed-rod for the upper carbon; F, the clamp therefor; G, the holder for the lower carbon; H, the globe, and I the globe-holder.

The mechanism-case A is constructed, as usual, with an inner frame comprising top and bottom plates *a* and *b*, respectively, connected together by any convenient posts or upright frames *c c*, as usual, the frame thus formed being insulated in any suitable manner from the exterior portions of the mechanism-case. Within this frame are the magnets and the feed mechanism.

K is the separating-magnet, *k* being its armature or movable member, and M is the feed-magnet, preferably a solenoid, *m* being its movable member, armature, or solenoid, core. The separating-magnet K is wound with coarse wire and is installed in the main circuit with the carbons, being commonly called the "main" magnet or "coarse-wire" magnet. The feeding-magnet is wound with fine wire and is arranged, as usual, in a shunt around the arc, being sometimes called the "fine-wire" magnet or "shunt-magnet." Ignoring for the present the special construction of these magnets, I will proceed to describe their connection with the operating mechanism.

The armature or movable member *k* of the separating-magnet is pivoted at one end and at the other or free end is connected by a link or connecting-bar J, which I will call the "bridge-piece," to one end of the feeding-lever L. The opposite end portion of this lever is connected to the armature *m* of the feeding-magnet M and to a retracting device or "retractor" which exerts a stress opposing the attraction of such armature. The lever L, between its points of connection with the bridge-piece J and armature *m*, is connected to the feeding device, which as a whole I will designate by the letter N. This feeding device is preferably a clutch, which in general is or essentially may be of any type usual in arc-lamps, but is preferably of the general construction heretofore used in the Wood clutch-feed lamps. This connection is effected by means of a link *d*, joined at its upper end to the lever L and at its lower end to the clutch-lever *e* of the feeding-clutch. This lever has a tail or opposite arm *e'*, adapted to be engaged by a stop or abutment *f*, as heretofore, and is pivoted at e^2 to ears on the clutch sleeve or barrel N', and to the lever is pivoted a contact-piece or clutch-shoe e^3, which is adapted to bear against the feed-rod. So far as concerns the generic features of my invention any other clutch may be substituted.

By reason of the clutch connection *d* engaging the lever L at a point between its connections with the feed-magnet armature on the one hand and the separating-magnet armature on the other any movement of either armature is communicated through the lever to the clutch.

The retractor for the feeding-magnet armature preferably engages this armature through the medium of the lever by means of a link *g*, jointed at one end to an arm L' of the feeding-lever and at its other end to one arm of a retractor-lever O, the opposite arm of which receives the pull of a retracting-spring S, the tension of which is adjusted by a screw *g'*, passing through any fixed part of the frame, as a cross-bar on one of the uprights *c*, and on which screws an adjusting-nut g^2, by which the screw can be propelled up or down. When the lamp is inactive, as in Fig. 8, the spring S draws the lever O until its long arm is stopped against the top plate *a*, whereupon the upper joint of the link *g* becomes a fixed point, and the lever L is suspended therefrom through the medium of the link *g*.

The retractor has the peculiar function of exerting against the armature or movable member of the feed-magnet a retractile stress which diminishes as the armature is drawn toward the magnet, as will be hereinafter explained.

The lamp is provided with a resistance-shunt R, consisting, as usual, of a coil of wire connected in a shunt short-circuiting the carbons and magnets. The cut-out controlling this shunt is peculiar. One terminal of the shunt is connected permanently to one lamp-terminal—for example, to the negative binding-post, as shown in Fig. 12—while the other end of the shunt is connected to what I will call a "shunt contact-piece" *p*, which in its preferred form is shown detached in Figs. 21 and 22. Ignoring for the present the specific construction of the cut-out contacts I will say

that the shunt contact-piece p is adapted to be touched by a contact-piece carried by the armature k of the separating-magnet in order that the attraction of this armature shall break the shunt-circuit and direct the current through the carbons before separating them. Cut-out contacts are also provided, so that upon an abnormal excitation of the feeding-magnet M the lamp is short-circuited through the shunt R. Separate pairs of cut-out contacts might be provided for these two operations; but preferably the same shunt-contact p is touched on the one hand by a contact k' on the armature k (preferably in the form of a roller, as shown in Fig. 26) and by a contact-piece q, (shown separately in Figs. 19 and 20,) and which is moved down so that it touches the shunt-contact p upon an abnormal inclination of the feeding-lever L. In the preferred construction the shunt contact-piece p is formed with a bend p', into which the end of the shunt-wire or flexible cable R' may be soldered, and with one or more (preferably two) laterally-projecting curved or spoon-shaped contact-arms p^2 and an upwardly-projecting contact-arm p^3. This contact-piece p is preferably carried on the bridge-piece J, although it must be insulated therefrom. I attach it to the cross-bar j of this bridge-piece, Fig. 18, by means of screws entering the holes in this bridge-piece, insulating bushings being interposed between the screws and the corresponding holes in Fig. 22. The arms p^2 project beneath the contact-roller k' on the armature, which roller is preferably mounted on a pin k^2, Fig. 26. Preferably the armature is connected to the bridge-piece J through the medium of the pin k^2, the ends of which project through slots k^3, Fig. 17, in said bridge-piece, which slots are elongated, as shown in Fig. 29, so as to give sufficient lost motion for operating the cut-out contacts k' p^3. In the preferred construction the contact-piece q is also carried by the bridge-piece J, but is not insulated therefrom, being connected thereto by a frictional pivotal connection, which is simply effected by turning up ears q', which project between the upper arms of the bridge J and have pivot-holes which coincide with the holes j' j', Fig. 18, in said bridge, and which are entered by the pivot-screws l, (shown in dotted lines in Fig. 14,) by which the lever L is pivoted to the bridge-piece J. The ears q' are made yielding, so as to press outwardly against the inner faces of the bridge-piece, and to increase the frictional connection the metal surrounding the pivot-holes is punched outwardly in conical form, as shown at q^3, Fig. 20, and projects into and engages frictionally correspondingly-coned faces formed on the bridge-piece surrounding the pivot-holes. The contact-piece q thus makes metallic conductive contact with the bridge-piece and is so frictionally connected therewith as to retain any position to which it is moved, while offering but slight resistance to any effort to swing it around the pivotal center. It is formed with a lower arm q^2, projecting downwardly and terminating in the contact-face for touching the arm p^3, and with an upper arm q^4, and the lever L is provided with a cross-bar l', which enters between the arms q^2 and q^4, in the manner shown in Figs. 8 to 11, so that an upward movement of the lever may cause the bar l' to lift the contact-piece q or a downward movement thereof may cause this bar to press down the contact-piece.

To moderate the movements of the armatures of the respective magnets I provide some suitable retarding devices, preferably dash-pots. In the preferred construction a dash-pot h is provided for the armature k and a dash-pot h' is provided for the armature m. The dash-pot h is not connected directly to the armature k, but is connected to the bridge-piece J, which latter is formed with ears h^2, Figs. 17 and 18, for this purpose. The dash-pot h' is connected, preferably, to the armature m through the medium of the lever L, the arm L' of which is prolonged and engages at its end with the dash-pot, as shown.

The lamp is provided with any suitable binding-posts, such as those shown at P P' in Fig. 5, to which the circuit-wires are connected. I have shown the post P connected metallically to the top plate a, which in turn is connected through springs i with the feed-rod E, the circuit being normally completed through the carbons, and from the lower-carbon holder G by wire i', which passes up along the frame, as usual, and is joined to the winding or coil of the magnet k, the opposite terminal of this winding being carried to the negative binding-post P', as shown in the diagram Fig. 12. The winding of the feed-magnet M is connected in a shunt i^2 between the top plate a and the wire i', (see Fig. 12,) so that the current flowing through this shunt joins that traversing the winding of the separating-magnet. When the lamp is cut out through the resistance R the current passes from the top plate a through the magnet-frame K' and armature k and through contacts k' and p into the resistance-shunt, and thence to the negative binding-post. When the carbons are consumed, the descent of the feed-rod cuts out the lamp in the usual manner by a head or flange pressing down a contact-spring n into contact with another spring n', so as to form a short-circuit between the binding-posts. The same effect is produced by turning the usual switch Q, which swings an arm r, (see Fig. 12,) connected with the negative binding-post, into contact with a spring r', connected to the positive binding-post.

The operation may now be understood. When the lamp is inert, or before the current is turned on, the lamp mechanism occupies the position best shown in Fig. 8, but shown also in Figs. 2 to 5. On turning on the current the current passes in part through the resistance-shunt R and in part through the

carbons and the winding of the separating-magnet, sufficient current traversing the latter to energize this magnet, which forcibly attracts its armature until the latter is stopped against the magnet-spool. The first effect of this movement is to separate the contact-roller k' from the contact-arms p^2, whereby the resistance-shunt is broken. This effect is produced while the ends of the pin k^2 are taking up the lost motion afforded by the elongated slots k^3. As soon as this pin strikes the upper ends of these slots the bridge-piece J is lifted, thereby raising the end of the lever L, to which it connects. In this movement this lever swings around its connection with the link g, and hence through the link d pulls up on the clutch N, causing the latter first to grip the feed-rod and then to move up bodily, lifting the feed-rod and drawing the arc. The upward movement of the bridge-piece J carries one or both of the pivot-screws l into a guiding-notch l^2 in the manner shown in Fig. 29, so as to steady this pivot, which now becomes the pivotal axis or fulcrum around which the feeding-lever L must turn in its future movements under the influence of the feeding-magnet. The notch l^2 is best formed in a hook-shaped guide or bracket o, Fig. 29, which is fastened to the upright or post c of the case and, if desired, may be made laterally adjustable in order to properly center the armature or solenoid-core m within the coils or spools of the feeding-magnet M. The position of the parts at the termination of this lifting movement is shown in Fig. 9. The resistance-shunt R is broken, the carbons have been drawn apart to establish the arc, and the entire current is traversing the arc, with the exception of that which is diverted through the coils of the shunt or feeding magnet M; but this in the preferred adjustment is at first insufficient to enable the pull of this magnet to overcome the tension of the retracting-spring S, and hence the retractor-lever O remains drawn up against the top plate a of the case. Shortly after the lamp has been thus lighted the lengthening of the arc due to the consumption of the carbons increases its resistance, and hence increases the impressed electromotive force by which the current is forced through the coil of the feeding-magnet M, so that the energy of this magnet becomes sufficiently increased to overcome the retractile stress, which begins to pull down its armature, and thereby to rock the retractor-lever O and distend the spring S. In this movement as the armature-lever L turns upon its fulcrum axis at the pivot-screws l it acts, through the link d, to lower the clutch bodily, and hence lowers the feed-rod and positive carbon, until finally the tail e' of the clutch-lever strikes the adjustable stop or abutment f, at which instant the normal feeding operation begins. This position of the mechanism—namely, that of normal feeding—is shown in Fig. 10. After this point is reached any further lowering of the feeding-lever releases the clutch and permits the feed-rod to slide down through it. This feeding movement shortens the arc, and consequently weakens the feeding-magnet, so that the spring draws up the armature-lever, reëngages the clutch, and arrests the feed the instant the arc is shortened to the proper length.

By reason of the special construction of the clutch hereinafter described, in connection with the sensitiveness of the feeding mechanism, the feeding action amounts in practice to a variable-brake action of the clutch upon the feed-rod, so that the latter is almost constantly descending through the clutch, the rate of its descent being nicely adjusted to the rate of consumption of the carbons by the action of the feed mechanism, so that the feeding is practically continuous instead of intermittent.

In case the feed-rod should stick in its guides or in the clutch and refuse to feed, the consequent lengthening of the arc beyond the normal increases the energy of the feeding-magnet, so that it exerts a stronger pull upon its armature and draws down the lever L until the position shown in Fig. 11 is reached. In this downward tilting movement of the lever its bar l' has pushed down the frictionally-mounted contact-piece q until the arm q^2 thereof in the lowermost position shown in Fig. 11 makes contact with the arm p^3 of the contact-piece p, and thereby again closes the shunt containing the resistance-coil R. This action short-circuits the lamp through the resistance-coil, thereby extinguishing the arc, (since in practice the resistance-shunt has only, for example, about one-fiftieth the resistance of the arc.) Hence the current through the arc and the separating-magnet K ceases and this magnet releases its armature k, which latter falls by gravity and in its descent first acts to bring its contact-roller k' against the concave contact-arms p^2, and hence establishes a new closure for the resistance-shunt, after which in continuing its descent the bridge-piece J and fulcrum end of the lever L move down with it, thereby lowering the clutch-lever and freeing the clutch. The short-circuiting of the arc through the resistance-coil is accompanied by the demagnetizing of the feeding-magnet M, whose armature is drawn up by the retractor. Thus the feeding-lever L is moved up at one end and down at the other almost simultaneously, and in this tilting movement the bar l', striking the upper arm q^4 of the frictional contact-piece q, tilts the latter upwardly to the position shown in Fig. 8, whereby its contact with the piece p is broken. This movement, however, is unaccompanied by any breaking of the shunt-circuit through R, because the latter is maintained closed through the contacts k' and p^2, as shown in Fig. 8. The sudden downward movement thus imparted by the dropping of the fulcrum end of the feeding-lever to release the clutch is accompanied

with sufficient shock so that it jars the feed-rod free, thereby insuring that this rod shall fall, and by bringing the carbons together re-establishes the main circuit through the carbons. When this occurs, the current again energizes the separating-magnet K, which immediately retracts its armature, and the lamp is lighted in exactly the same manner as at the outset, thereby reëstablishing the condition shown in Fig. 9 and repeating the series of operations heretofore described. The operation of relighting occurs instantaneously upon the contacts reaching the cutting-out position shown in Fig. 11, it being understood that Fig. 11 shows a position assumed at only one instant and immediately followed by the succession of operations just described.

In the movements of the armature k the dash-pot h performs an important function. In the initial or separating movement the armature moves up without restraint from the dash-pot until it has taken up the slack or lost motion in the slots k^3, after which, by reason of the dash-pot being connected to the bridge-piece J, it has to carry the dash-pot with it, and hence the lifting movement that it imparts to the bridge and to the lever L is a comparatively slow movement, which compels the arc to draw slowly and prevents breaking the circuit, particularly when the lighting movement is caused by starting up the dynamo with the lamps switched into circuit and being lighted simultaneously. During the falling movement of the armature k the same action of the dash-pot is repeated, in that the armature at first falls without retardation, so as to instantly close the cut-out contacts for the resistance-shunt circuit by taking up the lost motion in the slots k^3, after which the further movement of the armature, accompanied by the descent of the bridge-piece J and lever L, is moderated by the dash-pot. Thus the dash-pot holds up the bridge-piece J and prevents its falling too quickly, and this insures that the shunt-contacts k' p^2 shall be closed before the contacts q^2 p^3 are opened, and hence prevents the drawing of an arc between these latter contacts during their separation. An important requisite to this end is that the opening of the contacts q^2 p^3 shall be retarded, for if this opening occurred on the first upward movement of the armature m as the feeding-magnet is demagnetized by the lamp being short-circuited through R it would be liable to occur before the closing together of the contacts k' p^2, and hence would draw an arc which would oxidize and eventually burn out the cut-out contacts q^2 p^3. This is avoided by holding the contact-piece q frictionally in place against the contact-piece p until the armature m has executed a prolonged retractile movement—that is, until the lever has tilted so far as to strike the upper arm q^4, and thereby tilt the contact-piece q with it, which gives ample time to enable the armature k to fall and close together the contacts k' p^2. Any other frictional mounting of the contact-piece q or its equivalent which will leave it where it was moved by the abnormal excitation of the feeding-magnet until it is moved back by some later or retractile movement will be within this feature of my invention.

If the arc were blown out, the sudden increase in strength of the feeding-magnet M instantly draws down the lever L to the position shown in Fig. 11, and thereby short-circuits the lamp through the resistance-coil; but the first part of this movement releases the clutch, so that the feed-rod instantly begins to fall and brings the carbons together to reëstablish the normal circuit. The feeding-magnet is instantly deënergized either by the closing together of the carbons or by the short-circuiting of the arc through the resistance-shunt, if the latter should occur first, and the retractor pulls up the end of the feeding-lever to which the armature m is connected, so that this tilting movement of the lever (even without any lowering of its fulcrum end) acts to tilt the contact-piece q away from the contact-piece p, and thereby makes the first break in the resistance-shunt, after which, upon the subsequent re-energizing of the separating-magnet, the resistance-shunt is finally broken. The lamp is relighted by the upward movement of the armature k, as in the first instance. The proportions are such that the loose contact-piece q will be tilted so as to break contact with p either by the pulling up of the free end of the lever L without altering the position of its fulcrum or by lowering its fulcrum end without the retraction of its free end.

Having thus made clear the general mode of operation, I will now proceed to describe certain novel features of my invention.

The principal object of my invention is to increase the sensitiveness of the feeding mechanism, so that the feeding movements of the lamp may be accompanied by only a very minute or trifling variation in the energy expended in the lamp. In ordinary arc-lamps, where the feeding-magnet is in a shunt short-circuiting the arc, its energy varies according to the variations of impressed electromotive force due to the varying length of the arc, and hence to its varying resistance. When the arc is too long, this magnet is consequently strengthened and it acts to set the feeding mechanism into operation to impart a feeding movement, which in turn results in shortening the arc, and hence in weakening the feeding-magnet. The result of this mode of operation is that considerable fluctuations occur in the voltage or energy consumed by the lamp. To overcome these fluctuations, I compensate for the weakening of the magnet as the arc shortens by varying the mechanical advantage at which the spring stress is communicated to the magnet, so that as the armature is drawn to the magnet and the magnet is consequently weakened by the re-

sulting shortening of the arc the retractile force against which it operates shall give way or diminish in so nearly the same ratio as to retain the effectiveness of the magnet.

The tension of the retracting-spring increases as it is distended or otherwise flexed. To overcome this effect and produce the contrary result upon the armature—that is, to cause the retractile stress to diminish with the movement of the armature toward its magnet—the retractor-lever O is so devised as to vary the mechanical advantage at which the spring stress is communicated to the magnet, so that the communication of such stress shall be most effective when the armature is fully retracted and shall become progressively less effective during the attracting movement of the armature. To this end I so shape and arrange the retractor-lever O that the relative effective lengths of the two arms of the lever shall vary during the movement of the lever which accompanies the attracting movement of the armature in such manner that the effective length of the arm to which the spring is connected shall diminish proportionately to the effective length of the arm to which the armature is connected. This I accomplish, preferably, by so locating the fulcrum point or axis x upon which the lever turns that its point of engagement with the spring shall during the movement of attraction swing upward in an arc such that the line of stress of the spring shall during this movement continually approach the fulcrum-axis, and hence shorten the effective length of this arm. The arrangement may be such that the effective length of the other arm to which the armature is connected shall be correspondingly lengthened during this movement, or both effects may occur simultaneously. The essential result is that during the movement of attraction the effective leverage of the lever shall change to an extent greater than that sufficient merely to compensate for the increasing tension of the spring as it is distended, so that the retractile stress which is communicated to the armature shall actually diminish during the movement of attraction of the armature. In the construction shown the effective lengths of the two arms of the lever in three different positions thereof are indicated in Figs. 9, 10, and 11 by the double-headed arrow which intersects the axis x, the distance from the axial center to the arrow-tips indicating the effective lengths of the respective arms. From this it will be seen that the ratio varies from approximately 1 to 1.80 in Fig. 9 to 1 to 2.25 in Fig. 10 and 1 to 2.75 in Fig. 11, or, roughly speaking, the spring tension is diminished to almost one-half in Fig. 9 and to almost one-third in Fig. 11, this ratio of diminution exceeding the ratio of increase of the tension of the spring by reason of its distention. Of course the variation in ratio resulting from the proportioning of the lever must be varied according to the length of the spring, the throw of the armature, and the nature of the feeding-magnet, whereby its coefficient of attraction is varied. With the distinct separating and feeding magnets of my lamp and the feeding-lever arranged as described the retracting-spring forms the sole resistance to the attracting movement of the feeding-magnet. By varying the effective force of this spring, therefore, I cause the entire retractile stress to vary in the same desired ratio. The practical result of this feature of my invention is that whereas in ordinary arc-lamps consuming normally fifty volts the range of variation in feeding is from five to eight volts or more, in my improved lamp, which is designed to feed at forty-five volts, the extreme variation in feeding is less than volt and in normal operation is less than one one-fourth of a volt, while a change of three volts will move the armature of the feeding-magnet from its highest to its lowest point, where it operates the cut-out.

I design the magnet of my improved lamp to give the maximum lift and to economize to the utmost the electrical energy. To this end I provide but one air-gap in the magnetic circuit and provide for a long range of armature movement with the minimum variation of air-gap. To these ends the magnet K is constructed with a core K^2 within the coil or winding and an L-shaped frame K′ outside the coil, as shown, the armature k being pivoted to this outer frame and being formed with a hole through which projects the conoidal end or pole-piece of the core K^2. The hinge is preferably a knife-edge joint, as shown in Figs. 4 and 7, formed by providing a knife-edge s on the frame K′ and a groove s' in the armature, (see Figs. 23 to 26,) so that the armature may have a rocking contact with the knife-edge of the magnet. This construction gives a constant magnetic contact, which when the armature is down is reduced by the angular gap shown in Figs. 4 and 8; but upon the attraction of the armature this gap is closed, as shown in Figs. 7 and 9. By the conoidal head of the pole-piece projecting into the hole in the armature the single magnetic gap at this point is shortened and a long movement is given to the armature, accompanied by a relatively short magnetic gap when the armature is retracted. This forms a very powerful magnet that is very economical of energy, so that but little expenditure of electric power occurs in the magnet while the lamp is in use. To hold the hinged end of the armature from falling away from the magnet when the latter is deënergized, I form it with notches s^2, Fig. 26, which are entered by T-shaped projections s^3, fastened on the frame K′, as shown in Figs. 23 and 24, the heads of which project beyond said notches beneath the lower face of the armature, thus constituting a cheap and simple form of hinge.

A modification of the knife-edge hinge-joint for the armature is shown in Figs. 27 and 28,

where the magnet-frame K′ is cut off square at its bottom and has fastened to it a hinge-frame s^4, having ears s^5 turned down at its ends, while the armature k has hinge-ears s^6 passing freely through holes in these ears and driven or screwed into it. This also forms a cheap and suitable construction of hinge affording a very slight magnetic gap, which diminishes as the armature is attracted.

A further feature of my invention which contributes greatly to the sensitiveness and uniformity of the feeding action relates to the construction of the feeding-clutch. Ordinarily in such clutches the barrel N′ is simply a tube (in some cases having a grooved inner surface) making a loose fit with the feed-rod, so that the inner surface of the clutch makes contact with an extended area of surface of the rod. With this old construction there is liability that as the surface of the rod becomes dirty its extended area of contact with the clutch-barrel may cause it to stick therein and interfere with the smooth uniform feed of the clutch. To avoid this disadvantage, I form the clutch-barrel N′ to contact with the feed-rod at only four points, as clearly shown in Figs. 30 to 34—namely, at two upper and two lower points. To this end the barrel is hollowed out to a larger diameter than the rod between its top and bottom ends, as clearly shown, for example, in Figs. 5 and 9, so that it may be said to be formed with internal flanges $t\,t$ at top and bottom, which alone approach the rod, and each of these flanges is cut away in the manner best shown in Fig. 32, so as to leave projecting portions in contact with the rod at only two points t' t'. These contact projections t' touch the rod on its side opposite to that against which the clutch-shoe e^3 acts and in planes above and below the shoe. The result is what may be designated a "five-point" clutch, which touches the rod at points indicated in Fig. 34, where the shaded portions t^2 indicate the four positions of contact of the projecting portions t' of the clutch-barrel, and the dotted rectangle e^4 indicates the position of contact with the opposite side of the rod of the clutch-shoe e^3. As the clutch-barrel is guided solely upon the rod and supported solely upon the clutch-lever e, this construction results in a very nice and accurate adjustment of the clutch to the rod with the minimum practicable area of surface contact between the clutch and rod, so that the liability of sticking is reduced to the minimum and any particles of grit or foreign matter which may adhere to the rod are enabled to work through the clutch without interfering with its action upon the rod. The practical result of this feature of my invention is that instead of feeding by a succession of gripping and letting-go movements, so that the feed-rod is first held fast and then permitted to fall and again gripped and held fast, my improved clutch is adapted to feed after the manner of a friction-brake—that is to say, in feeding it does not entirely release the rod, but retains a frictional retardation thereupon, so that the rod slowly slides down through the clutch at a rate almost exactly proportionate to the rate of consumption of the carbons, thereby rendering the feed practically continuous instead of distinctly intermittent, as heretofore.

For adjusting the tripping-point of the clutch I make the abutment f adjustable. This abutment is formed as a small metal plate, the upper end of which is preferably bent to project into a slot in the standard f', in which slot the lever-tail e' moves and is guided. The abutment f is fastened to the standard by a screw f^2 engaging the standard and working through a slot in the abutment, as shown, for example, in Fig. 8. To adjust the abutment, the screw is loosened and the abutment is set up or down, its hooked end serving to keep it vertical, and the screw is retightened.

The positive-carbon clamp F is preferably of the construction best shown in Figs. 35 and 36. It has a stem u, which may be screwed or otherwise attached to the lower end of the feed-rod E, and from this stem or attachment it is formed with a downwardly-projecting shell or arm u', which lower down merges into a ring F′ of peculiar shape, a set-screw or thumb-screw u^2 being provided to clamp a carbon within this ring in the manner shown in Figs. 2 and 3 and Figs. 35 and 36. The ring F′ is preferably oval in cross-section, as shown in Fig. 35, although its exterior contour is immaterial. Internally the ring is egg-shaped in plan (see Fig. 36) and convex in cross-section, as shown in Fig. 38, which latter is an enlarged cross-section in the oblique vertical plane, (indicated by the line 38 38 in Fig. 36.) Hence the ring presents two points of contact with the cylindrical carbon C—namely, where its inner surface, which is concave in a horizontal plane, tangents the circumference of the carbon, as shown in the diagram Fig. 37, the tangenting-points being marked $y\,y$ in that figure. As its inner surface is convex in a vertical plane it tangents the cylindrical surface of the carbon in the manner shown in Fig. 38, where y' is the tangenting-point. The carbon is held against these tangent-points by the set-screw u^2, which is tightened against it in such manner that the carbon is gripped at three points as nearly equidistant as possible. By reason of the points $y\,y$ being on concave curves the carbon is at these points gripped with as little abruptness as possible, and hence with the minimum liability of breakage, and the curves compensate for any slight variations in the diameter of the carbon that may occur in practice. By reason of the contact-points being made with curves in vertical planes (see Fig. 38) the carbon is gripped as gently as possible, while affording means for compensating for crooked carbons by bringing the lower end of the carbon to its

proper position in the vertical axis at the expense of tilting or canting the upper end, where it is gripped in the clamp, this tilting being indicated to an exaggerated degree by the dotted line y^2 in Fig. 38. This simple construction of clamp affords thus a universal adjustment for the carbon without the provision of any moving part in the clamp except the thumb-screw thereof.

The lower or negative carbon D is held in a clamp G of usual construction, consisting of a tubular standard v, projecting up from its insulated attachment to the globe-holder I and provided at its upper end with a loose clamping-ring v', drawn against the carbon by a thumb-screw v^2. The tube v is open at its bottom end to enable the carbon to be thrust up through it from beneath. It is desirable to enable full-length carbons to be used as the lower or negative carbons, which requires that the surplus length shall project beneath when a fresh carbon is inserted, the half-burned negative carbon being raised when a new positive carbon is inserted in the lamp. Figs. 2 and 3 show the condition at, for example, the end of the first night's run, the upper carbon being consumed and the lower being burned down nearly to the holder G. To prepare for the second night's run, the trimmer will place a new upper carbon in the positive holder or clamp F and will raise the lower carbon D, so that its bottom end will be gripped by the clamp G. It is necessary to house the protruding portion of the negative carbon projecting beneath the globe-holder I, and for this purpose it has been usual to provide a long insulated tube, a construction which has been expensive and fragile and has sometimes caused accidents through carbon-dust or other conducting particles getting into the tube and making an electrical connection between the carbon and the tube. I avoid these disadvantages and provide a simpler and cheaper construction by forming the usual dust-cap T with a tubular downward extension T', formed, preferably, integrally with it, as one casting. This tubular extension T' is so much larger than the carbon that there is no danger of contact, while any particles of dust that may fall into it are given free escape through a bottom opening w, which also will drain off any moisture that will enter the cup, and also provides a ventilating-inlet through which air may ascend along the carbon and passing through the dust-cap and through the usual openings in the globe-holder may enter the globe. Any dust falling from the globe will drop through the openings in the globe-holder and be caught in the dust-cap T, an upwardly-projecting annular flange w' being provided to prevent this dust from entering the tubular extension T'. In trimming the lamp the dust-cap T is removed in the usual manner for emptying it of any dust which may have fallen into it, and this act uncovers and exposes the negative carbon.

The globe-holder I may be provided with any suitable means for engaging on its under side with the dust-cap T and on its upper side with the globe. Such provisions are shown in my Patent No. 426,405, dated April 22, 1890.

The lamp may be supported in any suitable way, the support shown, which forms no part of my invention, consisting of a socket U, screwed to the outer top plate of the mechanism-case and connected through an insulating-bar U', of wood or other material, with a metal hood U^2, which is fastened to a supporting arm or bracket.

The mechanism-case, although in general of ordinary construction, presents a novel feature designed to make the case fit more tightly without increasing the difficulty of applying its shell. The case has the usual cast top plate A', by which the entire lamp is supported, and to which the inner frame is fastened through insulating connections, this top plate having an outer pendent flange z. The case is inclosed, as usual, by a sheet-metal shell A^2, the upper end of which fits within the flange z, while its lower end is centered by and supported against a projecting insulating disk or ring b', fastened beneath the bottom plate b and projecting beyond it. I now form the shell A^2 with an inturned bead or rib z' at such level that when in place it meets and rests against the projecting edge of the disk b', as clearly shown in Fig. 4. This bead contracts the diameter of the shell A^2 at this level and makes a tight and moisture and dust proof connection between the shell and this insulating-disk. If the entire shell be contracted to this diameter in order to make such complete connection, it would be exceedingly difficult to push this shell up into place, especially after the swelling or warping of the ring b', which often occurs after a short usage of the lamp; but by making the shell of large diameter, so that it will easily pass the disk b' until its upper end has been inserted into the flange z, the shell is very easily pushed up into place and fits tightly only when the bead z' comes to its bearing against the disk or insulating projection b'.

It must not be inferred from the particularity of detail with which I have described the preferred embodiment of my invention that I am by any means limited to this one embodiment thereof, since, in fact, my invention is capable of being embodied in various mechanical constructions. Those features which are believed to be essential to my invention in its generic and specific aspects I have endeavored to define in the claims hereinafter contained.

As examples of the modifications of which my invention is susceptible, I may mention that the cut-out contacts for closing the shunt-circuit R may be greatly varied in arrangement, two possible modifications being shown in Figs. 39 and 40. In Fig. 39 the contact k', instead of being a roller carried by the armature

k, is an arm carried at the top of the bridge-piece J and touching a contact-spring p, which in this case is fastened on, but insulated from, the lever L. The lost-motion connection is in this instance made between the bridge J and the lever L by providing the fulcrum-pin l with a slot in which to work. Hence the retarding device, (the dash-pot h,) instead of being connected to the bridge-piece J as before, is here shown as connected to the lever L at near the fulcrum end thereof. The cut-out contacts for closing the resistance-shunt upon an abnormal excitation of the feeding-magnet M are also differently arranged, consisting of a contact-arm q^5, carried by the lever L and touching a contact p^5, mounted on a fixed support. The contacts p and p^5 are connected to the resistance-coil R. The contact-arm q^5 is connected by a frictional joint to the armature-lever at l^5, so as to retain any position relatively to the lever to which it is turned. On the downward movement of the lever a projection b' on this arm encounters a fixed pin b^2, whereby the contact-arm is tilted into contact with the fixed contact p^5. During the upward movement of the lever contact is maintained until the inclined face of the arm q^5 strikes the stop b^2 and tilts it away from p^5; but before this occurs the falling of the armature k has brought the arm k' against the spring p. In Fig. 40 the bridge-piece J, instead of constituting a link arranged vertically, constitutes a lever arranged horizontally as an extension of the armature k, and the lost-motion device consists of pins l^3 l^4, between which one arm of this lever may vibrate. In the upward movement of the armature k the lever J is first turned around the fulcrum-pin l until it strikes the pin l^3, in which movement its contact end k' parts from the contact-spring p, which in this instance is fixed to, but insulated from, the armature k. When the lost motion has thus been taken up, the lever J becomes a fixture of the armature and lifts the fulcrum-pin l, and hence lifts the lever L, the motion of which is retarded by the dash-pot h. When the armature k falls, its first movement takes up the lost motion by turning the lever J around the fulcrum-pin l until it strikes the lower stop-pin l^4, during which movement its end touches the contact-spring p. The cut-out contacts for closing the shunt R upon an abnormal excitation of the feeding-magnet consist of a fixed contact-spring p^6 and a movable contact-piece q^6, which latter is frictionally pivoted at l^6 to any fixed part and is tilted by a pin m^6, projecting from the armature m of the magnet, which upon the abnormal excitation of the magnet acts against a lower toe c' to press down the contact-piece against p^6, and subsequently upon the retraction of the armature strikes the upper toe c^2 to lift the contact-piece out of contact with p^6.

The feeding-clutch N may be modified to arrange its contact-points in the manner shown in Fig. 34ª, where instead of the two lower contact-points l^2 of Fig. 34 one lower contact-point l^2 is provided, so that the barrel touches one side of the feed-rod at two points above and one below the level of contact with the opposite side of said rod of the shoe c^5, or the two contacts might be arranged below and the one above, as if Fig. 34ª were inverted to like effect. The one contact-point l^3 is effected by forming the barrel with a single inward projection, (shown in dotted lines at l^4 in Fig. 32)

I claim as my invention the following-defined novel features, substantially as herein-before specified, namely:

1. An arc-lamp having distinct separating and feeding magnets, a lever connected at its normal fulcrum-axis to said separating-magnet and operated by said feeding-magnet, a resistance-shunt around the arc, and a cut-out adapted to be operated solely by the excitation of the separating-magnet to break said resistance-shunt independently of movements of the feeding-magnet.

2. An arc-lamp having distinct separating and feeding magnets, a lever connected at its normal fulcrum-axis to said separating-magnet and operated by said feeding-magnet, and a cut-out operated by an abnormal excitation of said feeding-magnet, whereby said cut-out is operated independently of movements of said separating-magnet.

3. In an arc-lamp, the combination with distinct separating and feeding magnets and a resistance-shunt, of a lever connected at its normal fulcrum-axis to said separating-magnet and operated by said feeding-magnet, and a cut-out operatively connected to said magnets for closing said shunt upon either an abnormal excitation of the feeding-magnet, or a demagnetization of the separating-magnet.

4. An arc-lamp having distinct separating and feeding magnets, a feeding device, a feeding-lever connected at its normal fulcrum-axis to the separating-magnet, connected for normal operation to the feeding-magnet so as to be moved by either magnet, and connected at an intermediate point to said feeding device to communicate the movement of either magnet thereto, a resistance-shunt, and a cut-out therefor operatively connected to said magnets for closing said shunt upon either an abnormal excitation of the feeding-magnet or a demagnetization of the separating-magnet.

5. An arc-lamp having distinct separating and feeding magnets, a feeding device, a feeding-lever connected at one end to the separating-magnet and at the other end to the feeding-magnet so as to be moved by either magnet, and connected to said feeding device to communicate the movement of either magnet thereto, a resistance-shunt, and cut-out contacts therefor operatively connected to the separating-magnet, and means whereby the excitation of said magnet first separates said contacts and thereafter communicates motion to said lever.

6. An arc-lamp having distinct separating

and feeding magnets, a feeding device, a feeding-lever connected at one end to the separating-magnet and at the other end to the feeding-magnet so as to be moved by either magnet, and connected to said feeding device to communicate the movement of either magnet thereto, the connection between said lever and separating-magnet being made through a lost-motion device, a resistance-shunt, and cut-out contacts therefor operatively connected to the separating-magnet within the limits of said lost-motion device, whereby the first movement of said magnet operates said contacts until the lost motion is taken up, and thereafter is communicated to said lever.

7. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a resistance-shunt, and two cut-outs therefor operatively connected to the respective magnets, so that the one is operated by movements of said separating-magnet, and the other by extreme movements of said lever around its point of connection with said separating-magnet.

8. An arc-lamp having distinct separating and feeding magnets, a lever connected at its normal fulcrum-axis to said separating-magnet and operated by said feeding-magnet, a resistance-shunt and two cut-outs therefor operatively connected to the respective magnets, so that the one is operated by movements of said separating-magnet, and the other by extreme movements of said lever around its point of connection with said separating-magnet.

9. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a resistance-shunt, and cut-out contacts therefor comprising an insulated contact-piece, a contact operatively connected with said separating-magnet to break contact with said insulated piece upon the excitation of said magnet, and a contact-piece connected with said lever to be moved by extreme movements thereof around its point of connection with the separating-magnet, both said contacts adapted to touch said insulated contact-piece for closing said resistance-shunt.

10. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a resistance-shunt, and cut-out contacts therefor comprising an insulated contact-piece, a contact connected with the armature of said separating-magnet, and a contact-piece connected with said lever to be moved by extreme movements thereof around its point of connection with the separating-magnet, both said contacts adapted to touch said insulated contact-piece for closing said resistance-shunt.

11. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, its connection with said separating-magnet being made through a lost-motion device, whereby the initial movement of said magnet will take up the lost motion thereof before moving said lever, a retarding device for retarding the movement communicated to said lever, a resistance-shunt, and a cut-out therefor operated by said initial movement while taking up such lost motion.

12. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a bridge-piece J connecting the armature of said separating-magnet to said lever, a resistance-shunt, and cut-out contacts therefor comprising a contact-piece fixed to said bridge-piece, and a contact on said armature adapted to touch said contact-piece.

13. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a bridge-piece J connecting the armature of said separating-magnet to said lever, a resistance-shunt, and cut-out contacts therefor comprising a contact-piece p fixed to and insulated from said bridge-piece, and a contact on said armature adapted to touch said insulated contact-piece.

14. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a bridge-piece J connecting the armature of said separating-magnet to said lever and having a lost-motion connection with said armature, a resistance-shunt, and a cut-out therefor comprising a contact-piece fixed to said bridge-piece, and a contact on said armature adapted to make or break contact with said contact-piece during the movements of said armature in taking up lost motion.

15. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a bridge-piece J connecting the armature of said separating-magnet to said lever, a resistance-shunt, and cut-out contacts therefor comprising a contact-piece p fixed to said bridge-piece, a contact on said armature adapted to touch said contact-piece, and a contact-piece q frictionally mounted and adapted to be moved into or out of contact with said piece p by extreme vibratory movements of said lever.

16. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a resistance-shunt, and cut-out contacts therefor comprising a contact-piece p and a contact-piece q, the latter frictionally mounted and adapted to be moved into or out of contact with the piece p by extreme angular movements of said lever.

17. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a resistance-shunt, and cut-out contacts comprising a contact-piece p and a contact-piece q, the latter frictionally pivoted at the point of connection between said lever and separating-magnet, and adapted to be moved into or out of contact with the piece p by extreme angular movements of said lever.

18. An arc-lamp having distinct separating and feeding magnets, a lever L connected thereto at different points, a bridge-piece J connecting the armature of said separating-magnet to said lever, a resistance-shunt, and cut-out contacts therefor comprising a contact-piece connected to said shunt having a concave contact-arm p^2, and a contact on the armature k of said separating-magnet consisting of a roller k' adapted to touch said concave arm.

19. An arc-lamp feeding-magnet combined with a retracting-spring, and an interposed lever adapted to vary the mechanical advantage at which the spring stress is communicated to the magnet, in such manner as to render such stress most effective when the armature is retracted, and progressively less effective as the armature is attracted.

20. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, and a retracting-spring for the feeding-magnet adapted to diminish its retractile stress during the attracting movement of said magnet.

21. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a feeding device connected to said lever at an intermediate point, and a retracting-spring for the feeding-magnet adapted to diminish its retractile stress during the attracting movement of said magnet.

22. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a feeding-clutch connected to said lever at an intermediate point so as to be moved by either magnet, and a retracting-spring for the feeding-magnet adapted to diminish its retractile stress during the attracting movement of said magnet.

23. An arc-lamp having distinct separating and feeding magnets, a feeding-lever connected to said magnets at different points, a retracting-spring for the feeding-magnet adapted to diminish its retractile stress during the attracting movement of said magnet, a resistance-shunt, and cut-out contacts for closing said shunt arranged to be operated by an abnormal attraction of said feeding-magnet.

24. An arc-lamp having distinct separating and feeding magnets, and a feeding-lever connected at its normal fulcrum-axis to said separating-magnet and connected for normal operation to said feeding-magnet, said separating-magnet being constructed with a magnetic circuit having only one gap, the armature thereof being hinged at one end, said gap existing between the free end of said armature and the pole-piece of the magnet, and the armature having an opening through which the pole-piece projects.

25. An arc-lamp having distinct separating and feeding magnets, and a feeding-lever connected to said magnets at different points, said separating-magnet being constructed with a fixed frame and an armature hinged at one end to said frame, and free to move at its other toward the pole-piece of the magnet, its hinge-joint shaped to diminish the magnetic resistance of said joint during the movement of attraction.

26. An arc-lamp having distinct separating and feeding magnets, and a feeding-lever connected to said magnets at different points, said separating-magnet being constructed with a fixed frame and an armature hinged at one end to said frame with a hinge-joint having an angular gap when the magnet is unattracted and arranged to close said gap by the attracted movement of said magnet.

27. An arc-lamp having distinct separating and feeding magnets, and a feeding-lever connected to said magnets at different points, said separating-magnet being constructed with a fixed frame and an armature hinged at one end to said frame with a knife-edge joint, the frame being formed with a knife-edge and the armature with a groove receiving it and leaving an angular gap when the magnet is unattracted, and arranged to close said gap by the attracted movement of said magnet, and a projection on the frame loosely engaging the armature to prevent its dropping off when unattracted.

28. In an arc-lamp, a feeding-clutch having its barrel cut away internally to reduce its contact with the feed-rod to a plurality of points of contact on the opposite side from the shoe, and having not more than two contact-points arranged on one side of the horizontal plane of the middle of said shoe, and one or more contact-points on the other side of said plane.

29. In an arc-lamp, a feeding-clutch having only five points of contact with the feed-rod, namely the shoe on one side of the rod, and two pairs of contact-points on the other side thereof, arranged above and below the level of said shoe.

30. A carbon-clamp for an arc-lamp comprising an elliptical ring having three points of contact with the carbon, one a clamping-screw, and the others formed in the ring as surfaces convex in vertical planes and concave in horizontal planes and making tangential contact with the cylindrical surface of the carbon.

31. In an arc-lamp, a tubular negative-carbon holder adapted to let the carbon project beneath it, combined with a dust-cup having a tubular extension adapted to inclose the pendent portion of the carbon.

32. In an arc-lamp, the drop-frame formed with a globe-holder, a tubular negative-carbon holder adapted to let the carbon project beneath said frame, and a dust-cup fitting beneath said globe-holder, having a tubular extension adapted to inclose the pendent portion of the carbon, and extended up within the cup to prevent dust falling into it.

33. In an arc-lamp, the mechanism-case having top and bottom plates, the latter be-

ing of insulating material and a shell A^2, said shell being formed with an internal bead to make a close fit with the annular projection b' of the bottom plate.

34. An arc-lamp having distinct separating and feeding magnets, and a feeding-lever connected to said magnets at different points, a bridge-piece for connecting the normal fulcrum-axis of said lever to the separating-magnet, and a guide having a notch or recess for properly locating such fulcrum-axis during its movement by said magnet.

35. An arc-lamp having distinct separating and feeding magnets, a resistance-shunt, and a cut-out therefor, means for operating said cut-out to close said shunt by an abnormal excitation of said feeding-magnet, and means for maintaining a closure of said shunt beyond the period of such abnormal excitation.

36. An arc-lamp having distinct separating and feeding magnets, a resistance-shunt, and a cut-out therefor, means for operating said cut-out to close said shunt by an abnormal excitation of said feeding-magnet, and means for maintaining said shunt closed until the completion of a normal retractile movement of said magnet.

37. An arc-lamp having distinct separating and feeding magnets, a resistance-shunt, and cut-out contacts therefor operated to close said shunt by an abnormal excitation of said feeding-magnet, one of said contacts frictionally mounted to retain any position to which it is moved, and connected to said feeding-magnet to be moved upon an abnormal attraction thereof, and upon a retraction thereof, to maintain a prolonged closure of said shunt between said movements.

38. In a clutch-feed arc-lamp, the combination with a clutch-lever of a fixed abutment for limiting its upward movement and an abutment for tripping the clutch, consisting of a plate fastened by a set-screw and vertically adjustable.

39. In a clutch-feed arc-lamp, the combination with a clutch having a clutch-lever, of a standard f' having a slot in which the tail of said lever may move, and a vertically-adjustable abutment f for closing the lower end of said slot.

40. In a clutch-feed arc-lamp, the combination with a clutch having a clutch-lever, a standard f' having a slot in which the tail of said lever may move, and a vertically-adjustable abutment f for closing the lower end of said slot, consisting of a plate bent at its upper end to enter said slot, and having a set-screw for adjustably clamping it to said standard.

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

JAMES J. WOOD.

Witnesses:
FRED S. HUNTING,
D. C. DAVIS.