(No Model.)

3 Sheets—Sheet 1.

J. DULAIT.

ARC LIGHT.

No. 424,866.

Patented Apr. 1, 1890.

Fig. 2.

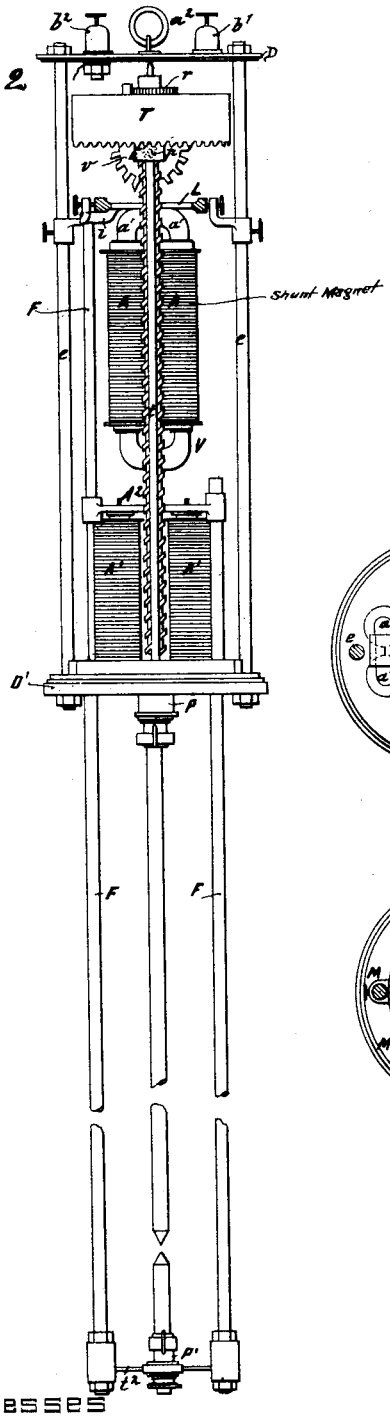


Fig. 1.

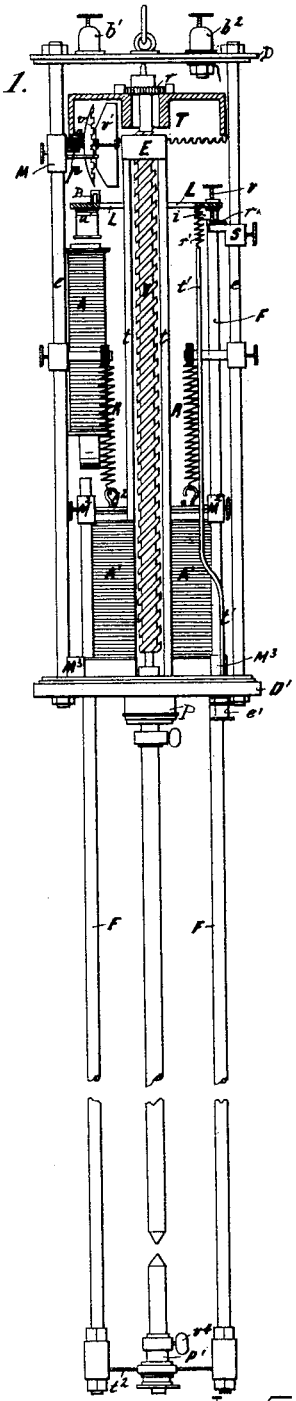


Fig. 5.

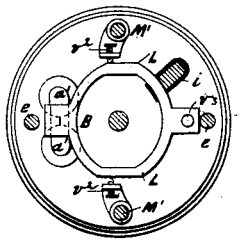


Fig. 3.

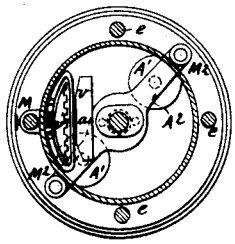
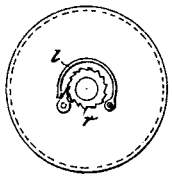


Fig. 4.



Witnesses

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(No Model.) 3 Sheets—Sheet 2.

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Fig. 6.

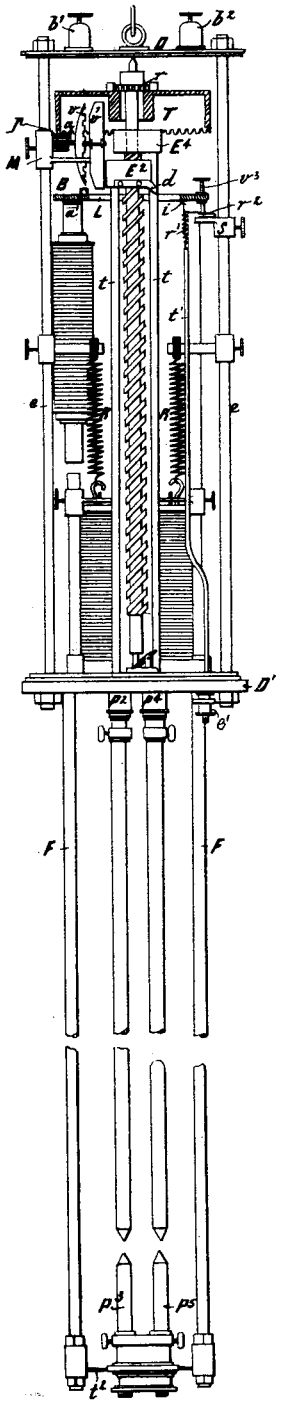


Fig. 7.

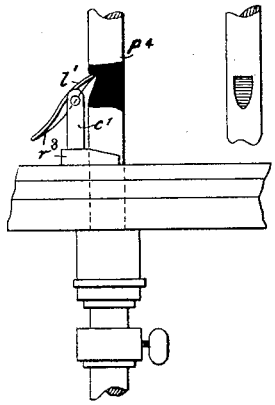


Fig. 8.

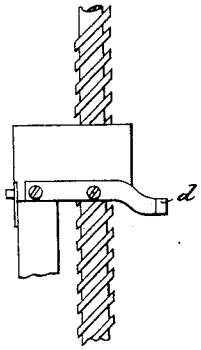
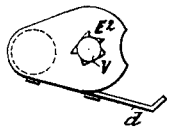


Fig. 9.



Witnesses

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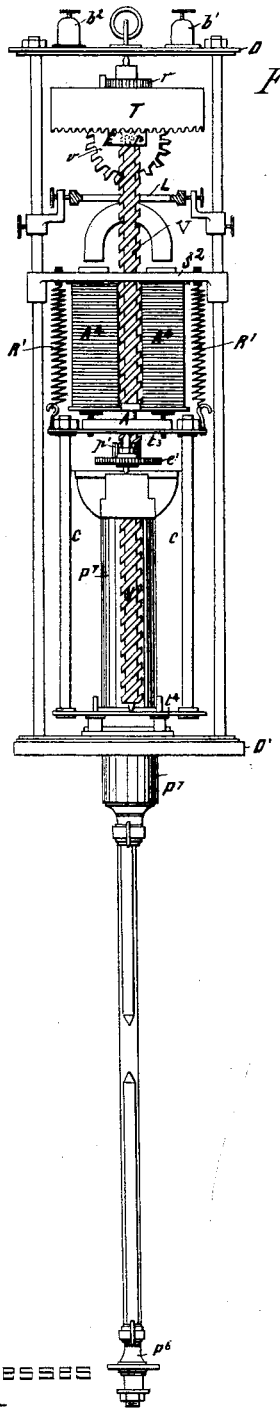

Fig. 11.

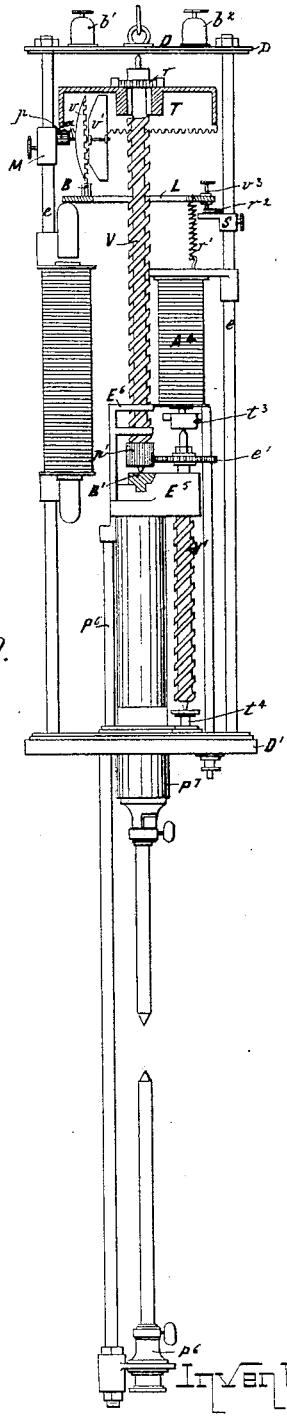

Fig. 10.

Witnesses

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UNITED STATES PATENT OFFICE.

JULIEN DULAIT, OF CHARLEROI, BELGIUM.

ARC LIGHT.

SPECIFICATION forming part of Letters Patent No. 424,866, dated April 1, 1890.

Application filed April 10, 1889. Serial No. 306,668. (No model.)

To all whom it may concern:

Be it known that I, JULIEN DULAIT, electrical engineer, a subject of the King of Belgium, residing at Charleroi, near Brussels, in the Kingdom of Belgium, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates to improved regulating mechanism for effecting the feed of the carbons of electric-arc lamps in such manner as to be exactly proportional to the consumption thereof, such mechanism being applicable with equal facility to a lamp with a single pair of carbons as to lamps with several pairs of carbons which are brought into action in succession, as also to a lamp with fixed luminous point, the light of which is reflected to the ceiling.

The construction of the mechanism is based on the method whereby the approach of the carbons for maintaining a uniform length of voltaic arc is obtained by the automatic descent by gravity of a carbon-holder, which is attached to a screw-nut that descends with it in a straight line upon a screw-spindle, which is thus made to rotate, the descent and consequent rotation being stopped as long as the arc remains of normal length, but being put in action again by means of an interrupting electro-magnet acting on a clock-work arrangement as soon as an approach of the carbons is rendered necessary by the slightest difference in the arc.

In the annexed drawings, Figure 1 is an elevation view, partly in section, of the lamp with a single pair of carbons. Fig. 2 is an elevation view of this lamp, seen at right angles to Fig. 1. Fig. 3 is a horizontal transverse section through the clock-work. Fig. 4 is an upper view of the drum or barrel of the clock-work. Fig. 5 is a transverse section of the lamp, showing a plan view of the interrupting-lever. Fig. 6 is an elevation view, partly in section, of the same lamp arranged for two pair of carbons being lighted successively. Fig. 7 is a view of part of one of the carbon-holders in this lamp with engaging click or pawl. Fig. 8 is an elevation view of one of the holder-nuts of this lamp with disengaging-finger for the pawl. Fig. 9 is a plan view of this nut. Fig. 10 is an elevation view, partly in section, of the lamp with arrangement for having fixed luminous point and reflecting the light to the ceiling. Fig. 11 is an elevation view of the same, seen at right angles to Fig. 10.

In the lamp with a single pair of carbons the screw-spindle V turns freely on points fixed at the centers of the two disks D and D′ at the upper and lower end of the lamp-frame, which is formed by these disks and the four connecting-rods *e*.

To the screw-nut E, which slides freely on the screw-spindle V, is fixed the positive-carbon holder P, by means of two lateral rods *t t*, the upper ends of which are fixed to the nut E, while the lower parts pass through the lower disk D′, acting as guide thereto, and thus preventing the nut E from rotating, the lower ends of the rods being connected to the carbon-holder P, the weight of the latter, together with that of the rods *t* and nut E, being thus made to act with a downward pressure upon the screw-spindle V, causing this to rotate, and consequently to allow of the nut and carbon-holder to descend in a straight line, so as to approach the positive carbon toward the negative one for bringing the luminous arc back to its normal length. When the nut and the carbon-holder arrive to this position, they are held stationary by means of a steel knife-edge B, which engages with the teeth of an escapement-wheel of a clock-work mechanism in connection with the screw-spindle V, which thus has its rotation stopped, thereby also stopping the descent of the nut and carbon-holder.

The clock-work mechanism, Figs. 1, 2, and 3, consists, essentially, of an edged disk T, carried by the upper end of the screw-spindle V in such manner that the disk is carried round thereby in one direction—namely, in that in which the spindle is rotated by the nut—while on rotating the spindle in the other direction by the upward movement of the nut the disk T remains stationary. For this purpose the end of the screw-spindle is provided with a ratchet-wheel *r*, situated on the upper surface of the disk T, which carries a catch that is made to gear with the ratchet-wheel by means of a blade-spring *l*. By this arrangement the disk is only carried round by the screw-spindle when the latter rotates in a direction contrary to that of the catch, Figs. 1, 2, and 4.

The spindle *a*, carrying a pinion *p*, star-wheel *v*, and fly *v′*, for facilitating quick rotation of the mechanism, is carried in a bearing

c of special construction. It consists of an oblong frame formed as a closed loop in order to support the two ends of the spindle *a*, so that the star-wheel *v* and the pinion *p* rotate within the loop of the frame, while the fly *v'* turns freely outside the frame *c*. This is fixed rigidly to a sleeve M, adjustably carried by one of the connecting-rods *e* of the lamp-framing, so that it can be fixed at a suitable height for effecting the proper engagement of the pinion *p* with the toothed rim of the disk T. This mechanism being put in motion by the revolution of the screw-spindle V, actuated by the weight of the nut E, it will readily be seen that if the knife-edge B is engaged between two teeth of the star-wheel *v* it will stop all rotary motion of the spindle *a*, and such arresting of the motion will be gentle, without shock to the screw-spindle V by the action of the small pinion *p* upon the large disk T, so that by this means the downward motion of the positive carbon P will be stopped. The knife-edge B is fixed on the end of a lever L, suspended at its middle and capable of being made to rock on the one hand by the action of a spring *r'*, which is thus made to lift the knife-edge B for making it gear with the teeth of the star-wheel *v* for the purpose of stopping the clock-work, while on the other hand the lever is actuated, by means of an electro-magnet A, with fine-wire coil, in such manner as to draw down the end of the lever carrying the knife-edge B, which thus frees the clock-work movements for the purpose above described.

The lever L instead of being a simple straight bar consists of two bars connected at their ends, but separating from each other toward the middle, so as to form an open frame, which surrounds the mechanism situated at the middle of the lamp, so that the lever does not in any way interfere with the action thereof, Figs. 1, 2, and 5. The points of suspension of this looped lever are situated on the two lateral bars, and consist of two centers, in which are engaged two points on the ends of steel regulating-screws v^2, which screw through nuts carried by sleeves M', that are fixed adjustably on the connecting-rods *e* of the framing, so that the position of the lever L can be regulated with great precision both vertically and laterally.

The tension of force of the counteracting-spring *r'*, fixed at the right-hand end of the lever L, can be regulated by adjusting screw-nut *e'*, screwed on the threaded end of a rod *t'*, passing through the lower disk D' of the frame, the upper end of the rod *t'* being attached to the spring *r'*.

At the left-hand end of the lever L is fixed an armature *a'*, of horseshoe form, situated immediately below the knife-edge B, the armature *a'* being made to correspond with the poles of the electro-magnet A, which is also of horseshoe form. This electro-magnet is fixed to the frame of the lamp and is included in a shunt-circuit on the lamp-circuit. This shunt-circuit can be opened and closed by means of a regulating-screw v^3, screwing through the right-hand end of the lever L, and having a platinum point which bears upon a weak spring r^2, which also has a platinum contact. The spring r^2 serves to facilitate and also to limit the oscillations of the lever L. It is fixed on a small support *s*, of ebonite, which insulates it entirely from the other part of the lamp, so that the spring is exclusively in connection with the shunt-circuit.

On the lower disk D' of the lamp-frame is placed symmetrically relatively to the central screw-spindle and insulated from the disk D' an electro-magnet with thick-wire coil A', and above this is an armature A^2, which is suspended by means of two springs R, that are attached by their upper ends to any convenient fixed point of the framing. They are, however, insulated from the frame. The armature A^2 is of flat form, but has an opening at the center, so as to embrace the central screw-spindle and allow the nut thereof to pass through it on its descent. The extremities of the armature A^2 are connected to two sleeves M^2, adjustably mounted on two rods F, which pass through the lower disk D' and are guided in two long ebonite sockets M^3, that are fixed on the disk and serve to insulate the rods F from the other part of the lamp. The lower ends of the rods F are rigidly fixed together by means of a cross-piece f^2, which is provided at its center with a socket having a large opening which constitutes the lower negative-carbon holder P', in which the carbon can be centered by means of regulating-screws v^4, in order to adjust it exactly in the same vertical axis as the positive carbon, toward which it is drawn by means of the springs R R, which operate against the attractive force of the electro-magnet A'. One of the rods F is prolonged far enough up to abut against a small insulating-block *i*, fixed on lever L. The electric current passes into the lamp thus arranged through the positive terminal *b'*, which is in conducting-connection with the upper disk D, so that the current passes through the lamp-frame to the positive-carbon holder P, which makes contact therewith by means of brushes or by other suitable means. The current passes from the positive carbon to the negative carbon, and thence through the metal rods F through a suitable electrical connection to the negative terminal b^2, insulated from the disk D. In this main circuit is also interposed the coarse-wire electro-magnet A' between the lower carbon P' and the negative terminal b^2.

The fine-coil electro-magnet is placed on a shunt-circuit of the main circuit by connecting it with the lower carbon by means of the terminal b^3, and on the other hand to the upper carbon by the contact of the interrupter r^2 v^3. At the center of the disk D is placed a ring a^2 for suspending the lamp. When no current is passing through the lamp, the points of the two carbons re-

main in contact through the action of the springs R R and the weight of the upper carbon; but as soon as the current passes the electro-magnet A′ attracts the armature A^2, and thereby causes the negative carbon to descend to a suitable distance for forming the arc which is thus produced. At the same time the rod F, leaving the insulating-block *i*, permits the lever L to vibrate by action of the spring *r′* and to suspend the upper carbon upon the action of the clock-work by intercalation of knife-edge B and the star-wheel *r*. As long as the length of the arc remains normal the lamp remains in this condition, but as soon as its length increases slightly the quantity of the current passing into the shunt electro-magnet A becomes greater, and it consequently attracts the armature *a′* with the knife-edge B, thus liberating the clock-work movement and permitting the descent of the upper-carbon holder. The shunt-circuit having been broken by the raising of the contact-screw v^3, immediately closes again under the action of the spring *r′*, and these oscillations are repeated very rapidly until the normal length of arc is re-established.

The regulator arranged as described for a lamp with a single pair of carbons is very easily applied to a lamp with two couples of carbons, and this modification is characterized mainly by the combination, with the central screw-spindle V, of two nuts E^2 E^4, each carrying separately its positive-carbon holder P^2 P^4, which is constituted in this case by a single rod *t*, passing through the lower disk D′, but being otherwise identical with that above described. Each positive-carbon holder has of course a corresponding negative-carbon holder P^3 P^5, arranged symmetrically upon the lower cross-bar t^2, Fig. 6. The screw-spindle V has the thread of its upper end removed, so as to turn freely in the upper screw-nut E^4, which is held while the other screw-nut E^2 descends on the screw-spindle, the lower end of this having also no screw-thread. The screw-nut E^4, with its carbon-holder P^4, is held in the raised position by a catch consisting of a lever formed as a pawl *l′*, which rocks on a small bracket *c′*, situated on the lower disk. The nose of the catch-lever *l′* enters into a notch p^4 at the lower end of the carbon-holder P^4, thus maintaining this in its raised position under the action of a small spring r^3, acting on the tail of the catch *l′*, which projects from the bracket *c′*; until a finger *d*, of suitable form and fixed to the screw-nut E^2, in descending on the screw-spindle V disengages the catch *l′*, and thus liberates the carbon-holder P^4, Figs. 6, 7, and 8. With the exception of these small constructive modifications the arrangement of the lamp remains the same as before described, and the action of the lamp with two couples of carbons operates as follows: When the upper carbon P^2 of the first couple is in contact with the corresponding negative carbon P^3, the carbon P^4 is situated away from its corresponding carbon P^5 to an extent at least equal to the height of the screw-nut E^2, and when now the current passes into the lamp the negative carbons are withdrawn, so as to separate the carbons of the first couple sufficiently for producing the normal length of the arc, while the distance between the carbons of the second couple is increased to such an extent that the current cannot exercise the slightest influence between the two poles. If, now, the upper carbon of the first couple is nearly consumed, the nut E^2 will have arrived nearly at the lower end of the threaded part of the screw-spindle V, and in leaving this it will slide down upon the unthreaded portion, but at the same time its finger *d* presses on the catch *l′*, which is thus disengaged from the notch of the carbon-holder P^4, and this being freed descends with its nut E^4 and engages in its turn with the threaded part at the upper end of the screw-spindle in order to descend upon this, and thus impart rotary motion to it by its weight. This rotation at the commencement of the descent of the nut E^4 increases in speed in the proportion to the increase of length of the arc between the carbons P^2 P^3, which do not any longer approach each other, and at the moment when the distance between these poles becomes excessive and the lamp becomes extinguished the current will not pass any longer and the opposing springs R R immediately raise the lower carbons. At the same time one of the rods F abuts with its upper end against a small insulating-block *i*, fixed on the lever L, thus raising the latter and allowing the teeth of the star-wheel *v* to pass round free of the knife-edge B, so that the nut E^4 then descends at an optional speed until the contact of the carbons P^4 P^5 takes place, thus producing the new arc. As the distance passed through for this purpose only amounts to a few centimeters and as the movements are effected with great rapidity, the extinction of the arc only lasts at most a few fractions of a second. It will readily be seen that if the portions of the screw-spindle V having no thread were made longer and if the necessary proportions of the other mechanism were made correspondingly, three or even a greater number of carbon couples might be applied in one and the same lamp, in order thus to increase to any desired extent the duration of the illuminating-power of the lamp.

The lamp, with a single pair of carbons first described, can be readily converted into a lamp with fixed luminous point which reflects the light to the ceiling. This modification is shown in Figs. 10 and 11 of the drawings. In this case it is preferable to place the positive carbon at bottom and the negative carbon at top, and to construct the screw-spindle in two parts, of which the upper one V, corresponding to the positive ascending carbon P^6, is situated in the center of the lamp, while the lower part V′, corresponding to the negative descending carbon

P^7, is placed in an eccentric position in the lamp-frame. The lower screw-spindle V′ is rotated by the weight of the negative-carbon holder P^7, which is made very heavy, and it transmits its rotation in the contrary direction and at any desired proportional speed to the upper screw-spindle V, the rotation of which raises the positive-carbon holder P^6. The negative-carbon holder P^7 is of cylindrical form, and it is guided in an insulating-socket inserted in the center of the lower disk D′. At the top of the carbon-holder P^7 is fixed a head E^5, forming a screw-nut, which is situated on the lower screw-spindle V′. This turns on points in corresponding centers on the cross-bars f^6 and f^8 of a frame C. The upper end of the screw-spindle V′ carries a toothed wheel e', which is insulated from the screw by ebonite washers, and can be adjusted at will by means of a screw-nut. The toothed wheel e' gears with a pinion p', fixed on the lower end of the central screw-spindle V, thus causing this to rotate. The upper screw-spindle V also revolves upon points, one of which is fixed on the end of an arm B′, secured firmly to the lamp-frame, while the other is situated in the center of the disk D. The two screw-spindles V V′ have the same pitch of thread. The positive-carbon holder P^6, having an upward motion, must consequently be made very light, contrary to the negative-carbon holder. For this purpose it consists of a simple rod, which is guided through the disk D′, having at its lower end, as negative-carbon holder, a socket allowing of adjustment for centering the carbon in the axis of the lamp, while at its upper end it carries the screw-nut E^6, which, for the sake of lightness, is formed of two branches, each of which only has a small amount of thread fitting on the screw-spindle, but both combined preventing any wedging action on the spindle. If requisite, the lower-carbon holder might be balanced entirely by means of a counter-weight attached to a cord or chain passing over a guide-roller situated at any suitable part of the lamp-frame. If under these conditions the consumption of the carbons takes place in the proportion of two to one, the positive carbon will have double the length of the negative carbon, and the gearing e' p' is proportioned so as to cause the positive-carbon holder to rise through a distance double that of the descent of the negative-carbon holder. By this means the luminous point will always be maintained at the same height. If the proportionate consumption increases or decreases, the carbons and the gearing will be correspondingly altered.

The upper cross-bar f^8 of the frame C, in which the lower screw-spindle V′ revolves, constitutes the armature A^3 of the coarse-wire electro-magnet A^4, introduced in the main circuit and situated in this case in about the middle of the casing, where it is fixed to a support S^2, suitably adjusted upon the vertical connecting-rods. The armature is guided by means of holes upon pins extending upon the one hand from the electro-magnet A^4 and on the other hand from the lower disk D′, insulated from the frame C, which is connected to the support S^2 by means of two suspension-springs R′ R′, which have for their object to weaken the concussion on the descent of the negative-carbon holder P^7 when the armature A^3 is separated from the electro-magnet A^4, as also for assisting it in its ascent when it is attracted by the electro-magnet.

In order that the motion of the frame C may not interfere with the position of the gearing e' p', the pinion p' is made of a proportionately increased height so as to remain in gearing with the wheel e' in whatever position the frame may be.

All the other parts of the lamp are similar to those described in the lamp with a single pair of carbons, so that the regulation is effected on the central screw-spindle V of the positive carbon P^6, which spindle also in this case carries the toothed disk T, and as this only turns in one direction with the screw-spindle, in consequence of its ratchet-connection therewith, it will be seen that for raising the screw-nuts the screw-spindles will turn freely in all three of the above-described constructions when these nuts E are raised by hand for replacing them in their original position.

When the lamp with fixed luminous point is ready to operate, the nut E^6 of the positive-carbon-holder is at the bottom of its course and the nut E^5 of the negative-carbon holder is at the upper end of its spindle V′, the points of the carbons being in contact. As soon as the current passes into the lamp the electro-magnet A^4 attracts its armature A^3 and raises the frame C, thus separating the carbons to the required distance for the production of the arc, which is then regulated as above described until the carbons are consumed, the points hereof being maintained constantly at the same height by the proportion of the gearing on the screw-spindles.

Having thus fully described my invention, the following is what I claim as new therein and desire to secure by Letters Patent—

In an electric-arc lamp, the combination, with screw-nut E and screw-spindle V, of regulating mechanism consisting of an electro-magnet A on a shunt-circuit of the lamp, a lever L, acted upon by the electro-magnet and carrying at one end a contact-screw v^3 and a spring r', and at the other end the armature a' and knife-edge B, a crown escapement-wheel v, gearing with said knife-edge and fixed on a spindle a, carrying fly-wheel v', a pinion p, also fixed on the spindle a, and a toothed-disk T, rigidly secured to screw-spindle V and gearing with the pinion p, all substantially as and for the purpose set forth.

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