(No Model.)

S. E. NUTTING.

ELECTRIC ARC LAMP.

No. 543,502. Patented July 30, 1895.

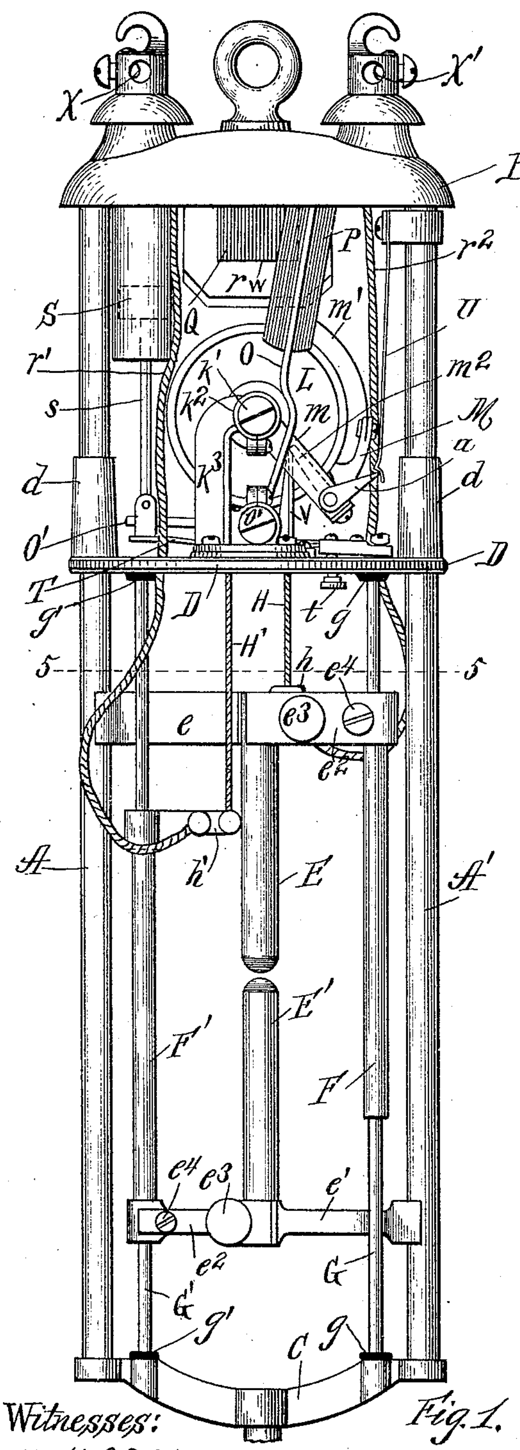

Fig. 1.

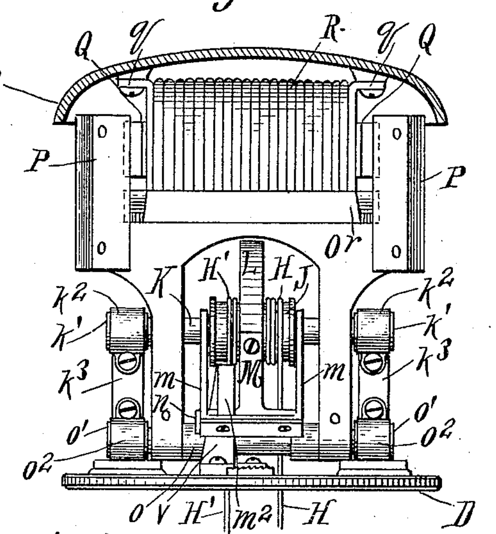

Fig. 2.

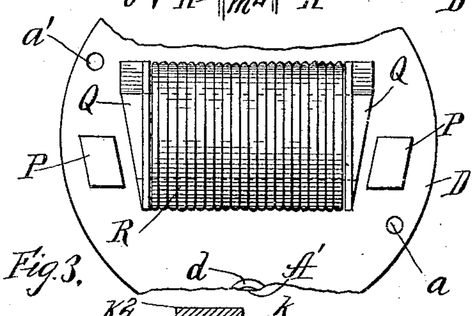

Fig. 3.

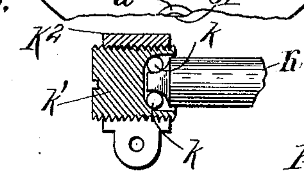

Fig. 4.

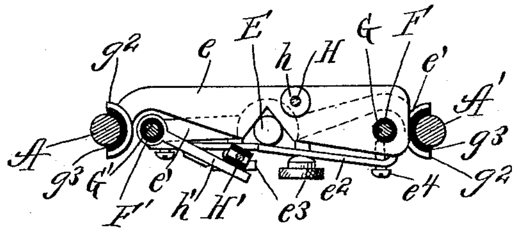

Fig. 5.

Witnesses:

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UNITED STATES PATENT OFFICE.

SAMUEL E. NUTTING, OF CHICAGO, ILLINOIS, ASSIGNOR TO GEORGE W. FURBECK AND JOSEPH KETTLESTRINGS, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 543,502, dated July 30, 1895.

Application filed April 5, 1894. Serial No. 506,380. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL E. NUTTING, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Arc Lamps; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to made and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

My invention relates particularly to constant-potential alternating-current arc lamps, though applicable in some of its features to other arc lamps. Its object is to adapt the lamp for use upon a circuit carrying a current of greater electromotive force than the lamp is capable of utilizing without using or wasting the excess of such force.

It has for further objects the improvement of the feed mechanism, whereby great sensitiveness combined with freedom from the vibration incident to the intermittent character of the current are secured, and an improvement in the means for carrying the carbons.

The invention consists of an electromagnet through which the entire current is carried, and which is constructed in such manner as to secure, in conjunction with an armature adapted to regulate the carbon feed, a definite relation between the counter electromotive force due to self induction and the current employed upon the circuit, in connection with which the lamp is intended for use, whereby the phenomenon commonly called the "choking effect" is employed to reduce the electromotive force delivered to the lamp practically to the capacity of the lamp.

It consists further in the peculiar form of the magnet and of the armature used in conjunction therewith for controlling the feeding mechanism, so that the attractive force applied to the armature is exerted in opposite directions and the armature is thereby balanced, of the special form of a brake-wheel mechanism co-operating with the armature, whereby the carbons are automatically fed and the length of the arc rendered uniform, and of supplemental rods for carrying the carbon holders, and of long bearings for such holders upon these rods.

It consists further of such other parts and arrangement of parts as are hereinafter set forth.

It is found advisable in practice to supply on an electric-light circuit a much higher electromotive force than the lamps employed are capable of utilizing. The surplus of voltage above the capacity of the lamp has usually been transformed into heat by the use of resistance in conjunction with each lamp. The heat has been lost, and as a result the service has been uneconomical, as the Watt meter has shown the consumption of current largely in excess of the candle-power obtained.

It is known that when an alternating current is passed through the coil of an electromagnet a counter electromotive force is induced in the circuit, which tends to neutralize or choke back the electromotive force of the current without transforming it into heat or in any way consuming it. I use the principle referred to for the purpose of controlling the current entering the lamp by employing an electromagnet within the lamp itself capable, with the armature, of causing by induction a counter electromotive force so proportioned to the electromotive force of the current and to the capacity of the lamp that the excess of the former over the latter is choked back and the record made by the meter is caused to practically coincide with the service actually performed. I also utilize the same armature in controlling the carbon-feed. The mechanism by which I secure these results is shown in the accompanying drawings, in which—

Figure 1 is an elevation of my improved lamp with its globe and casing removed. Fig. 2 is an elevation of the head of the lamp from a different point of view, the cap being in section. Fig. 3 is a plan view of the electromagnet and armature. Fig. 4 is a detail showing the journal-bearing of one of the shafts employed in the feed mechanism. Fig. 5 is a plan section on the line 5 5 of Fig. 1.

The frame of the lamp comprises the side rods A A′ fixed in the concave cap B at their upper ends and united by the cross-bar C at their lower ends. At D is shown a circular table supported by the rods A A′ and carrying the feed mechanism.

The upper and lower carbons are shown at E E′ and are held midway between the rods A A′ by the cross-heads e e', respectively, which are suspended by the cables H H′ wound upon the drum J in such manner that the rotation of the drum causes the carbons to move in opposite directions.

Supplemental rods G G′ extend from the table D to the cross-bar C, the former being located near the rod A′ and the latter near the rod A. These rods are set in the bushings g g and g' g' of non-conducting material.

The cross-heads e e' are mounted, respectively, upon the rods G G′, and sleeves F F′, sliding upon the rods G G′, are rigidly fixed to the cross-heads e e', respectively, and serve to prolong their bearings to insure easy action. Angular movement of the cross-heads e e' is prevented by placing them in contact, respectively, with the side rods A A′, their contact ends being formed with a crotch g^2 g^2 for the engaging of the rods. These crotches are bushed with a non-conducting material, as shown at g^3 g^3. Material having antifriction characteristics, such as soapstone, should be used for this purpose.

The drum J is carried by the shaft K, journaled in bushings k', screwed into the heads k of the floor-hangers k^3, secured to the table D, the shaft being diametrical as to the table. The cables H H′, depending from the periphery of the drum J, are therefore not central as to the carbons or the cross-heads and the metal of the latter is so disposed as to balance them, as shown in Fig. 5.

The cable H′ is connected to the cross-head e' by means of an arm h' projecting from the upper end of the sleeve F′, and its attachment to such arm, as well as that of the cable H to the cross-head e at h, is by means of a button of non-conducting material.

The lamp is focussed—that is to say, the arc is in a fixed position, the feed of the carbons being uniform. As they are hung from the same drum and gravity is depended upon as their motive force, the cross-head e is heavier than the cross-head e', the one sufficiently overbalancing the other to insure quick action when freed by the brake mechanism hereinafter described.

The holders or clamps for both carbons are alike. The cross-heads e e' are recessed, preferably in **V** form, and a clamp e^2 locks the carbon into this recess. The clamp e^2 is a short bar lying along the side of the cross-head and extending across the **V**-shaped recess and approximately to one end of the cross-head. Its outer end is held loosely by a screw e^4, and a binding-screw e^3 passes through it and enters the cross-head near the recess. The carbon having been placed in the recess, the bar e^2 is firmly pressed against it by turning up the binding-screw e^3. This method of securing the carbons I believe to be new. It adapts the lamp to any size of carbon and facilitates trimming.

The feed mechanism is of the class known as the "brake-wheel" feed, but possesses novel features of construction and action, whereby extreme sensitiveness is attained.

A brake-wheel L is fixed upon the shaft K with the drum J. The brake-shoe M frictionally engages the periphery of this wheel, and is pivotally carried by a pair of arms m, which, with the pivot-pin of the brake-shoe, form a frame which swings freely on the shaft K. A flexible connection unites the brake-shoe to the frame O, carrying an armature P. As shown, this connection is by a piece of light leaf-spring m'.

The frame O is carried by and is rigidly attached to a shaft o, journaled in floor-hangers attached to the table D and located below and parallel with the shaft K. The armature P co-operates with an electromagnet attached to the cap B, and consequently the armature is above the brake-wheel L. The length of the arms m is such that the brake-shoe M normally rests lightly against the face of the wheel L. As the armature radius is longer than that of the brake-shoe, strain applied to the spring m' by the movement of the armature tends to draw the brake-shoe against the face of the wheel L. This tendency is increased by the resistance of the shoe due to its weight, but more decidedly by the action of a retracting-spring U, secured to the frame of the lamp, as to the side rod A′, and bearing against the end of an arm u pivotally attached to and extending outward from one of the arms m, and when the brake-shoe is in the lowest position obliquely upward.

The brake-shoe is tipped or titled back from the wheel by an arm m^2 rigidly connected to it and extending inwardly from its lower end toward the axis of its frame and adapted for contact with a post v projecting upwardly from the table D.

The electromagnet is secured to the under side of the cap B by means of the frame q, and consists of a laminated core Q in bar form and a coil R carrying the entire current of the lamp. A mass of iron w is located immediately below the coil R and carried by the frame q for increasing the efficiency of the magnet.

The core Q is directly above and parallel with the shafts K o. The armature P is divided into two equal masses spaced apart, so that they may move before the faces of the core Q. The planes of the core-faces are oblique to the path of the armature, so that as the latter advances it is brought nearer to them. A lateral arm O′ extends from the foot of the frame O, and a retracting-spring T is secured to the table D in such manner as to bear against this arm and tend to throw the armature P back from the electromagnet, and a thumb-screw t is provided to co-operate with the spring T, whereby its tension may be varied.

When the magnet is excited by the presence of the current in the coil R the armature P is attracted, and as its advance movement upon its axis brings it closer to the poles of the magnet, owing to the inclination of the faces of the latter, the attraction set up causes it to so advance in opposition to the spring T. When the attraction is lessened the spring T draws the armature back.

A dash-pot S of ordinary construction co-operates with the spring T, its piston-rod s being attached to the arm O′. The dash-pot performs the usual function of preventing too abrupt action.

The forward movement of the armature P is limited by contact of the arm O′ with the table D, so that it never comes into actual contact with the core of the magnet.

By construction of the electromagnet in the form shown and described and the division of the armature into two masses (rigidly fixed to a carrying-frame common to both) co-operating with opposite poles, I am able to perfectly balance the armature and prevent any axial strain upon the shaft carrying it, as the strongest magnetic attraction of the one pole is directly in opposition to that of the other. For this reason I not only secure great freedom of action, but wholly prevent the chatter of the mechanism so common in alternating-current lamps and caused by the changes in polarity of the magnet.

The lamp is connected to the circuit by means of the binding-posts X X′. The coil R is connected with the post X and communicates with the carbon E through the wire r leading to the cross-head e. The binding-post X′ communicates with the carbon E′ through the wire r' leading to the arm h', the current being carried through the sleeve F′ and cross-head e'. The insulation of the rods G G′ at each end of the side rods A A′, where they are in contact with the cross-heads e e', and of the cables H H′ from the cross-heads to which they are attached, prevents the current from entering the frame of the lamp or any part thereof except the supplemental rods G G′ and the cross-heads e e'.

For the purpose of reducing the friction of the moving parts to the minimum, I prefer to use ball-bearings for the shafts K o, as shown in detail in Fig. 4. An adjustable bushing k' o', screwed into the heads k^2 o^2 of the hangers and having a concave chamber in its inner end, serves for the reception of the shaft end. The ends of the shaft K o are each turned down with a concave cut, so as to provide a race for the balls. The bushing k' o' may be set up so tightly as to wholly prevent longitudinal movement of the shafts and still allow the journals to move freely.

When the current is cut out of the lamp the armature P is drawn back by the spring T, the brake-shoe M is tilted back from the face of the wheel L by the contact of the arm m^2 with the post v, and the carbon is allowed to fall. The rotation of the drum J due to the descent of the carbon E winds up the cable H′ and the two carbons come together.

When the current is turned on the electromagnet is excited, the armature drawn up, carrying the brake-shoe with it, and the carbons are separated by the action of the brake-shoe upon the wheel L, the shoe impigning against the wheel, so as to carry it. As the resistance is increased by the lengthening of the arc, the current passing through the lamp, and consequently the energy of the magnet, are reduced and the armature recedes, the wheel L and the brake-shoe M traveling together until the arm m^2 comes again into contact with the post v. Further recession of the armature releases the wheel from the brake-shoe, and the carbons continue to approach. The increase of the current as the resistance at the carbon points is reduced immediately strengthens the magnetic attraction, and the pressure of the brake-shoe upon the wheel is at once increased and the rotation of the latter checked.

By the use of the strong electromagnet necessary to secure the adjustment of the current to the lamp, the indirect approach of the armature, as described, becomes possible, and a larger range of movement is secured. In consequence, the brake mechanism is not only extremely sensitive, but abrupt shifting of the carbons is avoided. The angular movement of the brake-shoe, by which its bearing upon the wheel is changed, being exceedingly slight relatively to that of the armature, its pressure upon the wheel varies so little after the carbon electrodes have found their most efficient position that it is never greater than suffices to stop the rotation of the wheel, and never reduced sufficiently to permit it to more than creep past it at a speed imperceptible to the eye. As the current varies with the most minute changes in the relation of the carbon electrodes, and as the magnetism responds to the slightest variation of the current, the vibrations of the brake-shoe within the limits indicated are practically as constant as the consumption of the carbon. By the mechanism employed I am therefore able to reduce almost to *nil* the impulses of movement of the carbons, and secure, as near as it is practically important to attain, a constant feed, and hence a practically uniform candle-power. Contributory to this result is the arrangement of the post v and the arm m^2, whereby the contact which tilts the brake-shoe is very near the center upon which its carrying-arms swing. In practice, the arm m^2 rests constantly but lightly against the post v. The practical elimination of friction and of lost motion from the mechanism by the use of ball-bearings and the discarding of gear-wheels is also an essential element in the solution of the problem of constant feed.

The feed mechanism is so responsive that the current can be turned on at its normal strength at the outset without danger of breaking the arc, and the light will become steady immediately.

The function of the tension-screw t is to adjust the length of the arc. As the tension of the spring T increases, the strength of current required to effect the advance of the armature increases. Consequently the arc is shortened by increasing and lengthened by diminishing the tension of the spring. Changes in this regard do not disturb the action of the feed mechanism.

In practice the parts H H′ will be the ends of a single cable, which will be prevented from slipping on the drum J by being lapped around it several times, or being made fast thereto in any desired manner.

The table D is formed with a pair of bosses d d, through which the apertures for the side rods A A′ are cut so that a long bearing is secured upon the rods, and the table is thereby held firmly in place.

I employ an electromagnet of the highest attainable efficiency for the purpose of securing the necessary counter electromotive force with the smallest possible magnet, and thereby economize space.

The number of ampère turns of wire and the amount of iron used are so proportioned that the counter electromotive force induced shall bear the necessary ratio to the electromotive force of the current.

By so disposing of the iron that, as shown, a considerable portion of it is in the armature, I am able to vary the induced counter electromotive force by the position of the armature relatively to the core of the magnet. As a consequence the current, increased by the approach of the carbons as they feed, is reduced to the desired quantity without greatly lengthening the arc, as the approach of the massive armature materially increases the induced counter electromotive force. By this means I am able to secure great uniformity in the light and in the current passing through the lamp.

The form of armature used, and of the ends of the magnet-core, as described, not only secures the balance of strain upon the armature, but makes it possible to utilize the powerful magnet necessarily employed to control the electromotive force of the current in operating the delicate feed mechanism, as the indirect approach of the armature measurably neutralizes the powerful attraction of the electromagnet; or, differently stated, the construction and relation of parts are such that powerful magnetic attraction is necessary to swing the armature upon its axis.

I claim as my invention—

1. In an arc lamp supplied with alternating electric current impulses, the combination with an electro-magnet in circuit with the lamp, of an armature co-operating with the magnet and adapted to control the carbon feed of the lamp, the magnet and armature being so related that the induced counter electro-motive force of the magnet varies with the changes of position of the armature, whereby the current supplied to the lamp is regulated.

2. The combination with an arc lamp supplied with alternating electric current impulses, of an electro-magnet adapted to adjust the electro-motive force of the current to the capacity of the lamp by its induced counter electro-motive force, an armature for co-operating with the electro-magnet, and mechanism actuated by the armature for controlling the carbon feed of the lamp, substantially as described.

3. The combination with an arc lamp, of an electro-magnet having a core in bar form and its polar faces divergent, of a forked armature moving transversely to the polar axis of the magnet and having its arms spaced apart so as to embrace both poles of the magnet, and mechanism actuated by the magnet for controlling the carbon feed of the lamp, substantially as described and for the purpose specified.

4. In an arc lamp the combination with an electro-magnet, of a pivoted armature, a carbon supporter, J, a brake-wheel moving with the carbon supporter, a brake-shoe adapted to frictionally engage the brake-wheel and pivotally mounted upon a frame swinging concentrically with the brake-wheel, flexible connection between the brake-shoe and the armature, means for yieldingly resisting the strain of the armature upon the brake-shoe, a tripping post located between the brake-shoe and the axis of its supporting frame, a trip arm rigidly attached to the brake-shoe and adapted for contact with the post as the armature recedes from the magnet whereby the brake-shoe is tilted on its pivot and released from contact with the brake-wheel, substantially as described and for the purpose specified.

5. In an arc lamp the combination with an electro-magnet, of a swinging armature having an indirect approach to the magnet, a carbon carrier, J, a brake-wheel moving with the carbon carrier, a brake-shoe adapted to frictionally engage the brake-wheel and being pivotally mounted upon a frame swinging concentrically with the brake-wheel, flexible connection between the armature and the brake-shoe, means for yieldingly resisting the strain of the armature upon the brake-shoe, an arm, m^2, rigidly connected with the brake-shoe and projecting toward the axis of its suporting frame, a trip for contact with the arm, m^2, as the armature recedes whereby the brake-shoe is tilted backwardly from the face of the brake-wheel substantially as described and for the purpose specified.

6. In an arc lamp having a fixed position for its arc, the combination with a pair of vertically reciprocating carbon holders differentiated in weight, a drum for carrying the carbon holders and adapted to be rotated by gravity, cables for supporting the carbon holders and wound oppositely upon the drum,

a brake-wheel mounted rigidly with the drum, a brake-shoe frictionally impinging against the brake-wheel and being pivotally mounted upon a frame swinging concentrically with such wheel, an electro-magnet, an armature for cooperating with and having an indirect approach to the electro-magnet, flexible connection between the armature and the brake-shoe whereby the advance of the armature draws the shoe to the brake-wheel, means for yieldingly resisting the strain of the armature upon the brake-shoe, an arm rigidly connected with the brake-shoe and extending toward the axis of its supporting frame, a trip for engaging the arm as the armature recedes and tilting the brake-shoe backwardly from the brake-wheel, substantially as described and for the purpose specified.

7. In an arc lamp the combination with a frame comprising a pair of side rods, a cap or cover uniting the upper ends of the rods, a cross-bar uniting the lower ends thereof, and a table, D, carried by the side rods, between the cap and the cross-bar, of a pair of supplemental rods extending from the table to the cross-bar and insulated at both ends, a pair of carbon carrying cross-heads differentiated in weight, and each having a long sleeve mounted upon one of the supplemental rods and an insulated bearing against one of the side rods, a drum supported by the table D, cables for supporting the cross-heads and having insulated attachments thereto and being wound oppositely upon the drum, means for automatically controlling the rotation of the drum, and means for conveying the electric current to the cross-heads, substantially as described and for the purpose specified.

8. In an arc lamp, the combination with the frame of the lamp, and with a vertically reciprocating cross-head for carrying the carbon and having a V-shaped recess for its reception, of a clamping bar electrically connected with the cross-head and over-lapping its recess and presenting a straight face transverse to the carbon, said bar having one of its ends loosely secured to the cross-head, and a binding screw between the attached end of the bar and the recess for drawing the bar to the cross-head.

9. In an arc lamp the combination with the table, D, the side posts, A, A′, depending from the table, and the cross bar, C, connecting the lower ends of the posts, of supplemental vertical rods, G, G′, rigidly set in and electrically insulated from the table and the cross-bar, and carbon holders, *e*, *e*′, adapted to slide respectively upon the rods G, G′, and to engage respectively the posts A, A′, said holders being electrically insulated from the said posts, substantially as described and for the purposes set forth.

10. In an arc lamp the combination with the table D, the side posts A, A′, depending from the table, and the cross-bar C, connecting the lower ends of the posts, of supplemental vertical rods G, G′, rigidly set in and electrically insulated from the table and the cross-bar, and carbon holders *e*, *e*′, adapted to slide respectively upon the rods G, G′, said holders being electrically insulated from the said posts, substantially as described and for the purpose specified.

In testimony whereof I affix my signature in presence of two witnesses.

SAMUEL E. NUTTING.

Witnesses:
LOUIS K. GILLSON,
M. H. L. WING.