No. 608,723. Patented Aug. 9, 1898.

T. SPENCER.

ELECTRIC ARC LAMP.

(Application filed Sept. 29, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1,

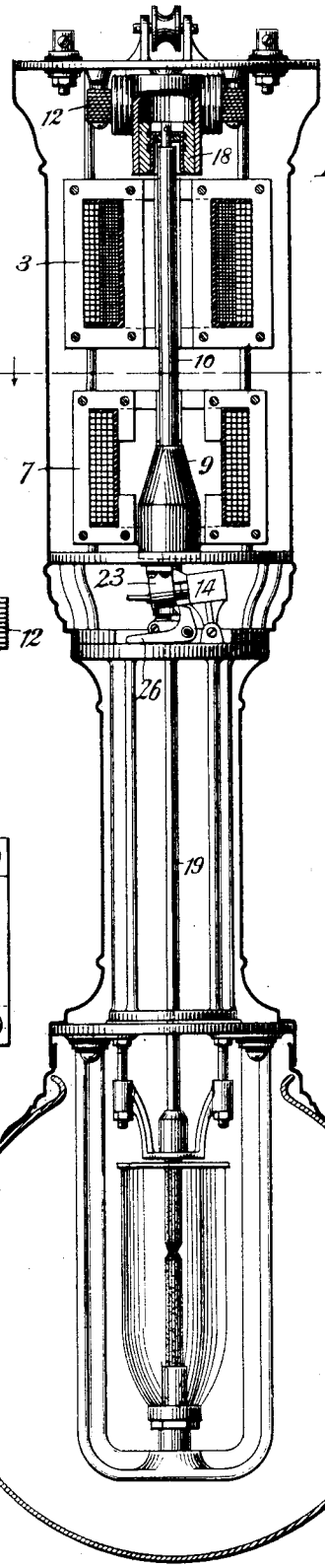


Fig. 2,

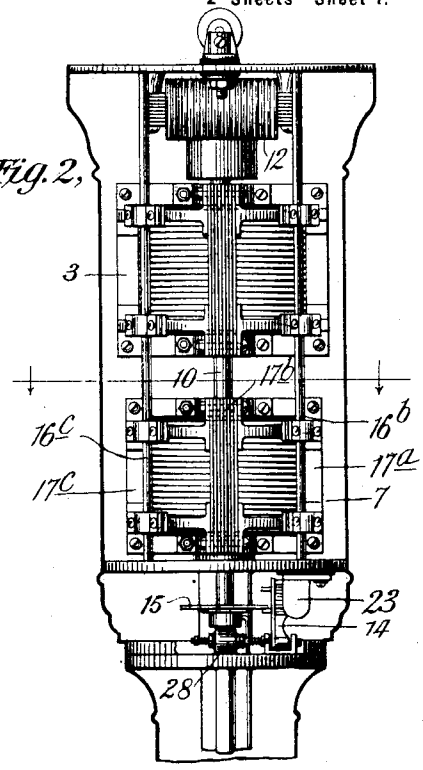


Fig. 4,

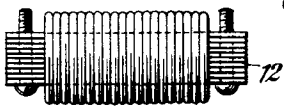


Fig. 5,

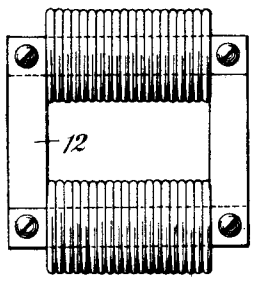
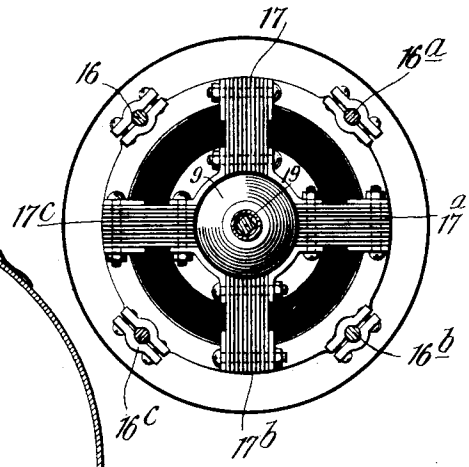


Fig. 3,



WITNESSES:

C. E. Ashley

Elizabeth Ewing

INVENTOR:

Thomas Spencer

By his Attorney

Robert Read.

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(No Model.) 2 Sheets—Sheet 2.

Fig. 6.

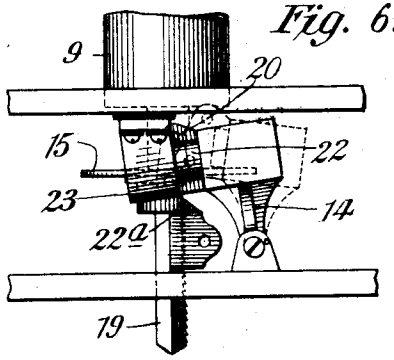


Fig. 7.

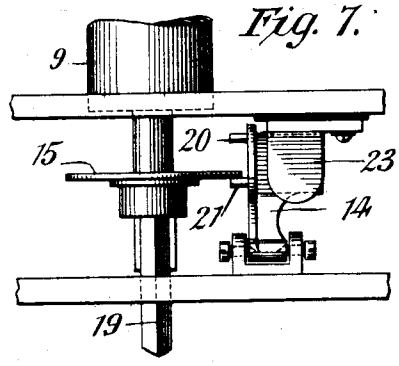


Fig. 8.

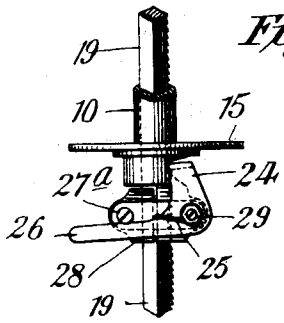


Fig. 9.

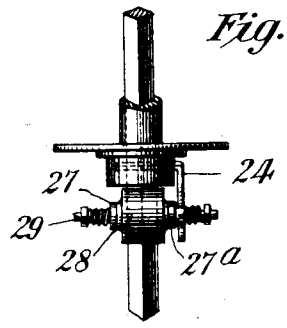
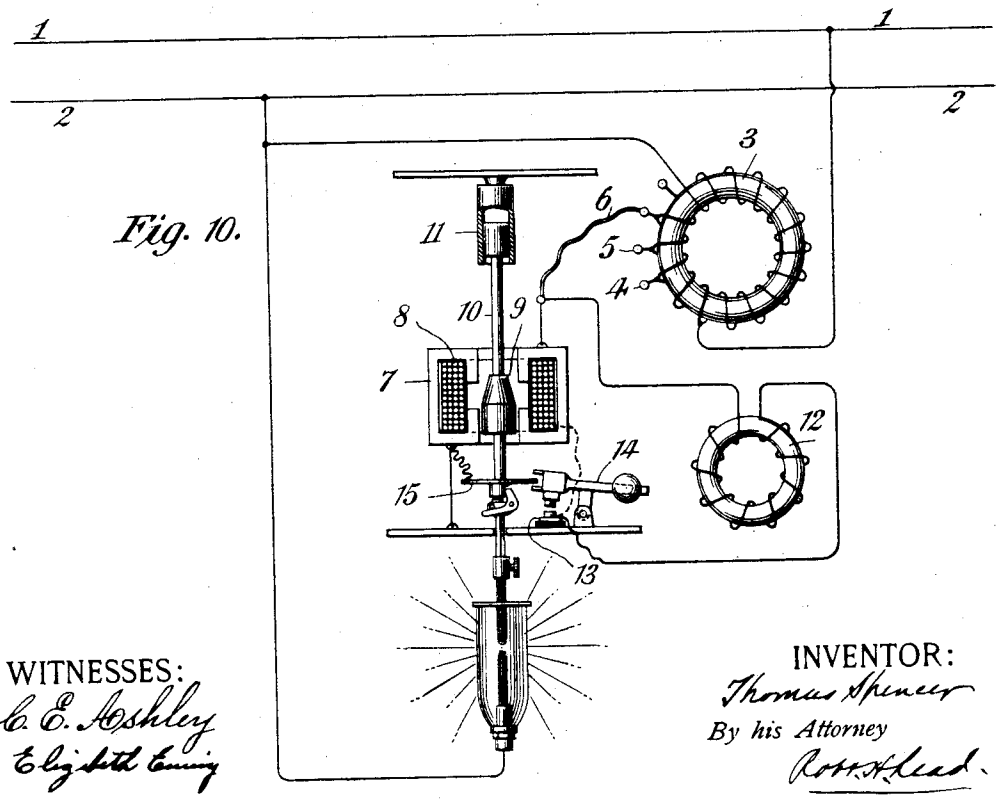


Fig. 10.



WITNESSES:
C. E. Ashley
Elizabeth Ewing

INVENTOR:
Thomas Spencer
By his Attorney
Robert H. Read.

UNITED STATES PATENT OFFICE.

THOMAS SPENCER, OF PHILADELPHIA, PENNSYLVANIA.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 608,723, dated August 9, 1898.

Application filed September 29, 1897. Serial No. 653,436. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SPENCER, of Philadelphia, county of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

This invention relates to arc-lamps of that type in which the arc is inclosed within a small transparent or translucent chamber to which air from the atmosphere has difficult access and into which the carbon pencil or electrode is fed by regulating mechanism as the carbons waste away under the action of the arc. The invention is particularly designed to permit such a lamp to be operated on an alternating-current circuit. In the attempts that have been made heretofore with such lamps on an alternating-current circuit it has been found necessary to use cored carbons in order to permit the arc to be maintained with a sufficiently small current to admit of operation at a reasonable efficiency. A further difficulty has been found in the fact that solid carbons prevent the lamp from starting by reason of the coating of graphite which is formed at their confronting ends. In inclosed arcs, however, cored carbons cause a deposit on the small chamber which surrounds the arc, which interferes with the effectiveness of the light. This coating is principally due to the large amount of silicious material used in the cores of such carbons.

It is a further object of my invention to permit solid carbons which are made commercially of a high degree of purity to be used in such lamps, my lamp being so constructed that the arc may be effectively maintained with a current of small amperage.

It is a further object of my invention to provide a clutch which will be sensitive in action, admitting of feed at very short intervals without possibility of overfeed.

In carrying out the invention I provide a mechanism for controlling the feed of the carbons which is very sensitive to slight changes of current strength and will act promptly in preventing a rupture of the arc. I provide also means for causing an increased current to flow when the lamp is started in order to break down the graphite deposit above referred to and permit the lamp to start with certainty.

My lamp comprises a clutch of increased sensitiveness and an arc-regulating coil containing considerable inductance and provided with means for adjusting the lamp to different rates of alternation of the supply-circuit. It comprises also a transformer forming part of the lamp structure by which the voltage of the current may be increased from fifty or one hundred volts, which is ordinarily maintained on commercial alternating-current circuits, to a point which will permit an effective lamp action, means being provided for adjusting the voltage within sufficiently wide limits to accommodate such variations of voltage as are found to exist in different commercial circuits and leave the lamp in its best working condition.

It comprises also means for increasing the amperage of the current when the lamp starts. For this purpose I prefer to employ a small choke-coil, forming part of the lamp structure, although other devices may be substituted for this, as will be hereinafter more fully explained.

In the accompanying drawings, which illustrate the invention, Figure 1 is a sectional view, part in elevation, of a lamp embodying my improvements. Fig. 2 is a side elevation of the upper part of the lamp, the direction of view being at right angles to that of Fig. 1. Fig. 3 is a top plan view of the regulating-coil and inductance which springs and controls the arc. Figs. 4 and 5 are side elevation and plan, respectively, of the small choke-coil employed to furnish additional starting-current when the lamp is started. Figs. 6 and 7 are elevations, on planes at right angles to each other, of the device which controls the increase of starting-current. Figs. 8 and 9 are elevations, on planes at right angles to each other, of the clutch I prefer to employ; and Fig. 10 is a diagrammatic illustration of a lamp embodying my invention.

Referring first to Fig. 10, 1 and 2 represent an alternating-current-supply circuit which in commercial practice may carry nominally fifty or one hundred volts, but practically varies somewhat from these limits. These voltages are insufficient to maintain a constant arc, and I provide a transformer 3, by which the voltage may be raised to a minimum value of one hundred and fifty volts, thereby per-

mitting my lamp to be used on ordinary commercial circuits. The transformer shown is of a character known as the "autotransformer," and comprises a single coil inclosing a laminated iron core. I wind this transformer so that it will be capable of raising the voltage of the line-current from fifty or one hundred to one hundred and fifty volts, and provide a range of contacts 4 5, &c., by which the number of active turns may be raised by connecting a flexible conductor 6 with the desired contact.

7 is the arc-regulating coil of the lamp. It comprises an almost complete magnetic circuit for a coil 8, said circuit being formed of four piles of laminated iron plates such as is shown in Fig. 3. The magnetic circuit is open on the inside, as shown in Fig. 10, to promote a good operation on a tapering core 9, connected to a tube 10, which carries the clutch mechanism and in which is suspended by a clutch the rod which carries the movable carbon.

The upper end of the tube 10 is connected to a dash-pot, by which the feed action is steadied, said dash-pot being suitably supported from the top plate of the lamp. In parallel arc with the regulating-coil is a small choke-coil 12, which leads to an insulated contact 13, provided with a carbon-button confronting a similar button mounted on a cut-out device 14, electrically connected with the lamp-frame, said device being adapted to cut into and out of the arc-circuit the branch including the choke-coil for the purpose of increasing the current through the arc at the moment of starting. A suitable switch is provided on the lamp for making and breaking the circuit, which it has been deemed unnecessary to illustrate.

As thus constituted the mode of operation is, briefly, as follows: The transformer 3 raises the voltage of the operating-current to one hundred and fifty volts or thereabout. When the lamp is in open circuit, the carbons are held together by the weight of the carbon-holding rod and its connected parts. A disk or projection 15 has engaged a pin on the cut-out 14 and tilted the latter so as to bring the carbon-buttons into contact. Thus the choke-coil branch of the circuit is closed, and when the lamp is cut into circuit a stronger current passes through the arc than is permitted after the lamp is lighted. This increased strength of current serves to break down the graphite deposit at the junction of the carbons and permits an arc to be drawn when the regulating-core 7 lifts the core 9 and separates the carbons. The cut-out device shown in the diagram is for simplicity of illustration shown somewhat different, as will be hereinafter more fully described. The action of the clutch will be apparent after the other figures of the drawings have been described.

Referring now to Figs. 1 and 2, it will be seen that the choke-coil 12 is hung upon posts at the top of the lamp-casing and that the transformer 3 and the regulating-coil 7 are supported in a line on four vertical posts 16 16^a 16^b 16^c, to which they are clamped. The construction of the transformer and the operating-coil is similar, except that the magnetic circuit on the former is completely closed, as shown in Fig. 1, whereas the latter is open on the inside to permit a suction on the core 9. Each of these coils is provided with a magnetic frame or skeleton formed of four bundles of sheet-iron 17 17^a 17^b 17^c, held together by brackets at the top and bottom, as indicated in Figs. 2 and 3. The bolts which clamp the bundles of plates to the brackets serve also to lock together the several plates of each bundle. The choke-coil may be conveniently made, as shown in Figs. 4 and 5, of four piles of iron laminæ, bolted together into a rectangular frame and provided with two small wire coils of sufficient carrying capacity and inductance to raise the starting-current to double the normal amperes.

The autotransformer 3, as indicated in Figs. 1 and 10, is provided with two connected windings of wire of different size, the one being made coarser than the other to increase its carrying capacity for the operating-current of the lamp. The mode of connection and the relationship of the coils is indicated in the diagram Fig. 10. The core 9 is rigidly connected with a tube 10, the top of which carries a plunger 18 of a dash-pot supported on a post on the under face of the top plate of the lamp. The rods 16 16^a, &c., are of sufficient length to permit vertical adjustment of the regulating-coil 7, which may be set at different positions by loosening the clamps which surround the rods and adjusting to the position desired. This adjustment varies the inductance of the regulating-coil by shifting the magnetic field with relation to the core 9. The latter, it will be observed, is made tapering, which gives an increased range of adjustment. By this construction the lamp may be easily accommodated to different periodicities of alternating current. By rendering the regulating-coil adjustable with relation to the working position of its core its inductance may be varied so that the same working current may flow with any periodicity between seven thousand two hundred and sixteen thousand reversals per minute. The carbon-holding rod 19, which may be made of brass square in cross-section, is provided on one edge with teeth, as indicated in Figs. 6 and 8, the rack being housed within the tube 10, which connects with the core of the regulating-coil. The lower end of the tube 10, which passes through the core, carries a disk 15, which controls the movements of the cut-out 14. The practical construction of this cut-out is shown in Figs. 6 and 7. The cut-out is pivoted or trunnioned in suitable bearings below its center of gravity and is provided with two studs 20 and 21, projecting into the path of the disk 15. These studs are so spaced with relation to the limits of

movement of the regulating-core that the disk 15 will engage the lower stud 21 just before the carbons come into contact, thereby tilting the cut-out 14 and bringing the two carbon-buttons 22 22ª into engagement when the arc goes out. The cut-out is, however, not operated to close the auxiliary branch by the feeding of the lamp, but is only closed when a lamp is cut out of circuit or a carbon breaks. The branch circuit to the choke-coil being thereby completed an increased current flows through the arc, breaking down the graphite deposit and causing the core 19 to rise and bring the disk 15 into engagment with the stud 20, thereby tilting the cut-out and opening the contact between the carbon-buttons 22 22ª. One of these buttons is mounted on the tilting weight 14 and the other on an insulated bracket secured to the frame of the lamp, as indicated in Figs. 1 and 6, the branch circuit through the choke-coil being led to the bracket. The function of the cut-out is important when the lamp has been extinguished, thereby permitting the carbons to get cold. With a lamp as commonly constructed if it is turned on before the carbons have cooled off it will start at once without jumping; but if a short time elapses after the lamp is extinguished, thereby permitting the carbons to cool, the lamp will start with difficulty and will jump until the carbons get sufficiently hot to start the arc. The object of the cut-out of the present case is to very much increase the starting-current, so that the necessary heating effect to provide for the arc is produced almost instantly, thereby permitting the arc to be sprung without the least jumping. The clutch I prefer to employ comprises a dog 24, (seen best in Figs. 8 and 9,) pivoted on an extension or bracket fastened to the lower end of tube 10. A slot cut in the bracket permits the nose of the dog to engage the rack on one corner of the carbon-holding rod 19, as clearly shown in Fig. 8. A spring 25 tends to hold the dog in engagement with the rack. The dog is provided with a horizontal extension 26, which bears upon the bed-plate of the lamp-frame, as shown in Fig. 1. When the carbons are in contact, the weight of the carbon and its holder forces the dog away from the rack and releases the carbon-rod. Pivoted to the same bracket which carries the dog 24 are two links 27 27ª, upon which is pivotally supported a clutch-shoe 28, provided with a V-shaped groove embracing one corner of the carbon-rod 19. Two light coil-springs mounted on the arbor 29, on which the dog 24 is pivoted, give a normal downward tendency to the links. The parts are so arranged that the arm 26 of the dog will engage when moving upwardly with a screw or lug on one of the links. In lieu of the choke-coil for increasing the strength of current the cut-out 14 may be arranged to short-circuit part of the operating-coil when the contacts are brought together, as indicated by dotted lines in Fig. 10, which serves to cut down the inductance and permit an increased current to flow when the lamp is starting. This organization, however, is not so effective as the choke-coil, which latter is much to be preferred in practice.

As thus constituted, the operation of the lamp is as follows: When the lamp is out of action, the magnet 7 is deënergized and the core and its connected parts drop, bringing the arm 26 upon the bed-plate of the lamp, as seen in Figs. 1 and 2. This throws the dog away from the rack, and by engagement with the stud on the link to which the brake-shoe is pivoted, raises the latter and frees the carbon-holding rod, permitting it to drop until it is arrested by the engagement of the two carbons. It also operates a cut-out and closes the auxiliary branch, including the inductance 12. When the lamp is thrown into circuit, there are two branches for the arc-current, one by way of the regulating-magnet, disk 15, and carbon-rod and the other by way of choke-coil 12, cut-out 14, and carbon-rod. Thus a sufficiently large current is permitted to pass through the arc to break down the graphite deposit above referred to. The regulating-magnet 7 is energized, lifting up the core 9 and freeing the arm 26, thus permitting brake-shoe 28 to fall and bind on the square edge of the carbon-rod. Immediately afterward the dog 24 engages with the rack and positively prevents slipping of the clutch. Thus the arc is sprung and will continue to burn until the core 9 has been lowered sufficiently to bring the arm 26 into engagement with the bed-plate, when the dog and friction-clutch are released from the carbon-rod, permitting the latter to feed, after which an increase of current strength again lifts the core 9 and preserves the lamp in operation. It will be noted that the carbon-holder is gripped on two opposite edges, causing a symmetrical movement and preventing binding when feeding is necessary; also, that if the friction-clutch should by accident permit the carbon-rod to slip, as is sometimes the case and is the occasion of considerable difficulty in clutch-fed lamps, the dog comes instantly into action and acts as a lock against overfeed. Thus the clutch serves to regulate the feed for very small increments and the dog prevents derangement from jars, vibration, or other causes.

The auxiliary circuit controlled by the cut-out 14 is not closed except when the lamp is out of circuit, as by a broken carbon or the operation of the controlling-switch. This result is effected by mounting the parts so that when the core 9 drops low enough to cause feeding the carbon-buttons of the cut-out will not be quite in contact.

The circuits of the lamp may be traced as follows: The primary circuit leads from the main 1, through the fine wire of the converter 3, back to main 2, and the secondary passes from one terminal by flexible con-

ductor 6 to and through the regulating-coil 8 to disk 15, carbon-rod and arc back to the free terminal of the fine wire of converter 3. The auxiliary branch when closed permits a large current to flow into its secondary circuit by a decrease of the aggregate inductance, since, as is well known, two inductances in parallel offer less impedance than one.

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

1. The method of operating an alternating-current arc-lamp consisting in automatically reducing the inductance of the arc-circuit when the lamp is starting into action.

2. An alternating-current arc-lamp provided with two paths for current to the electrodes, one of said paths including a cut-out actuated when the arc is sprung, whereby a starting-current of abnormal strength is admitted to the electrodes.

3. An alternating-current arc-lamp provided with a regulating-coil and a cut-out actuated when the arc is sprung to cut down the current strength, whereby a starting-current of abnormal strength is admitted to the electrodes.

4. An alternating-current arc-lamp provided with a regulating-coil, an independent branch circuit leading to the arc, an inductance in said branch circuit, and a cut-out controlled by the lamp mechanism to open the branch when the arc is started.

5. An alternating-current arc-lamp provided with a transformer of variable voltage having its primary and secondary circuits wound to raise the voltage at the lamp-terminals above that of the mains.

6. An alternating-current arc-lamp provided with a transformer wound to deliver a voltage sufficient to maintain the arc with a current of small amperage, and means for automatically raising the current strength when the arc is being started.

7. An alternating-current arc-lamp provided with an arc-regulating coil adjustable relatively to the core, whereby the starting inductance of the coil may be adjusted.

8. An arc-lamp provided with a regulating-magnet comprising a plurality of bundles of iron laminæ embracing the coil, having an air-gap on the side facing the core and brackets for spacing the bundles and holding them rigidly together.

9. An alternating-current arc-lamp provided with a transformer and arc-regulating coil housed within the lamp and supported on a plurality of vertical rods, and means for adjusting the regulating-coil on said rods so as to shift it with relation to its core.

10. An alternating-current arc-lamp containing two branch circuits both common to the arc-circuit one including the regulating-coil and the other a tilting cut-out to close or open when the carbons are in or out of engagement and thereby alter the inductance and permit a heavy current to flow when the lamp starts, for the purpose described.

11. A feed-regulator for an arc-lamp comprising a carbon-holder provided with teeth, a dog coöperating with the teeth, and a friction-clutch controlled by the regulating-coil to feed the carbon-holder, said clutch coöperating with the dog to set the latter after a definite range of movement of the clutch.

12. A feed-regulator for an arc-lamp comprising a dog 24 engaging one side of the carbon-holder, said dog having an extension adapted to engage a fixed part of the lamp to release the holder, and a clutch-shoe 28 impelled into engagement with the other side of the carbon-holder, said clutch-shoe being released after and through the agency of said dog.

13. A feed-regulator for an arc-lamp comprising a dog 24 engaging a rack on one corner of the carbon-holder, said dog having an extension 26 adapted to engage a fixed part of the lamp, and a clutch-shoe adapted to engage the opposing corner of the carbon-holder, said clutch-shoe being controlled by the dog.

14. A feed-regulator for an alternating-current arc-lamp comprising regulating-coil 7, core 9, a clutch movable therewith comprising dog 24 engaging one corner of rack 19, link 27, clutch-shoe 27^a engaging an opposite corner of the rack, and projection 26 cooperating with a fixed part of the lamp to release the dog and clutch-shoe when the core descends a determinate distance.

In testimony whereof I have hereunto subscribed my name this 27th day of September, A. D. 1897.

THOMAS SPENCER.

Witnesses:
GEORGE W. CLEMENT,
FRANK S. MARR.