(No Model.)

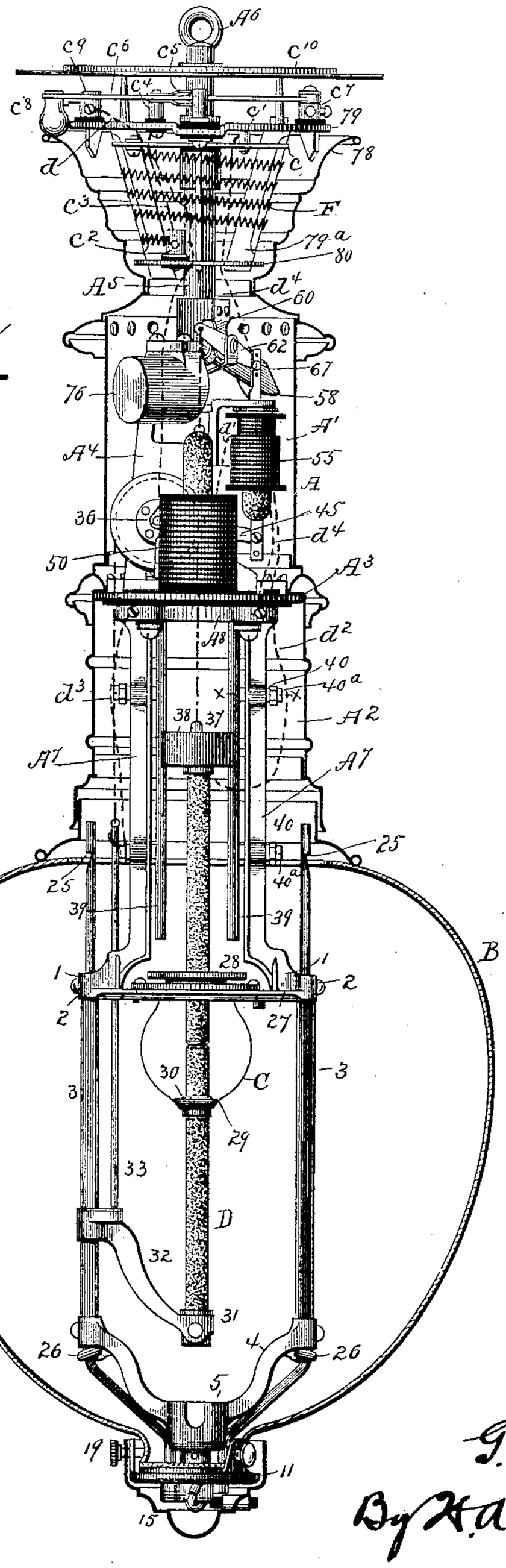
6 Sheets—Sheet 1.

G. R. LEAN.

ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

FIG. 1.



Witnesses
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(No Model.)

6 Sheets—Sheet 2.

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ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

FIG. 5.

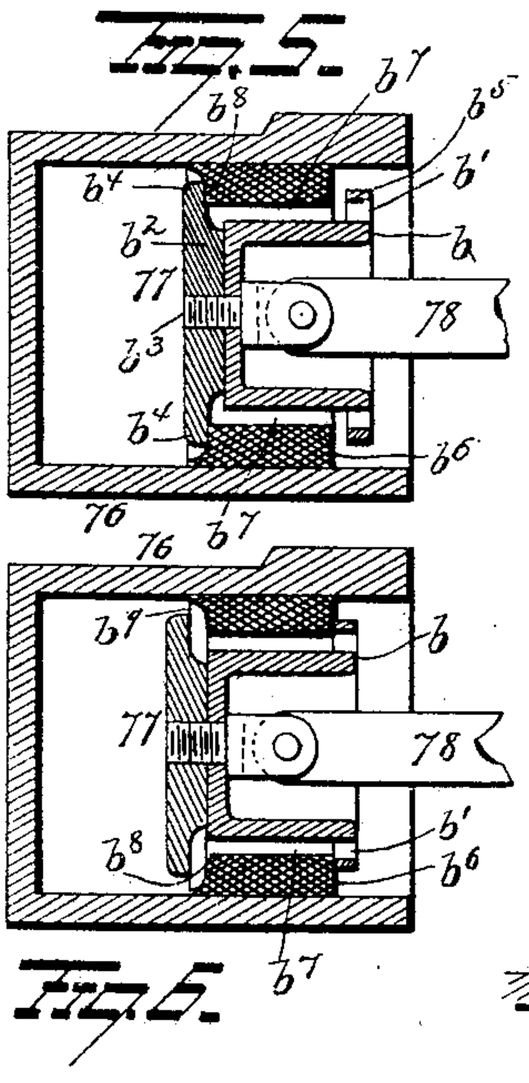


FIG. 6.

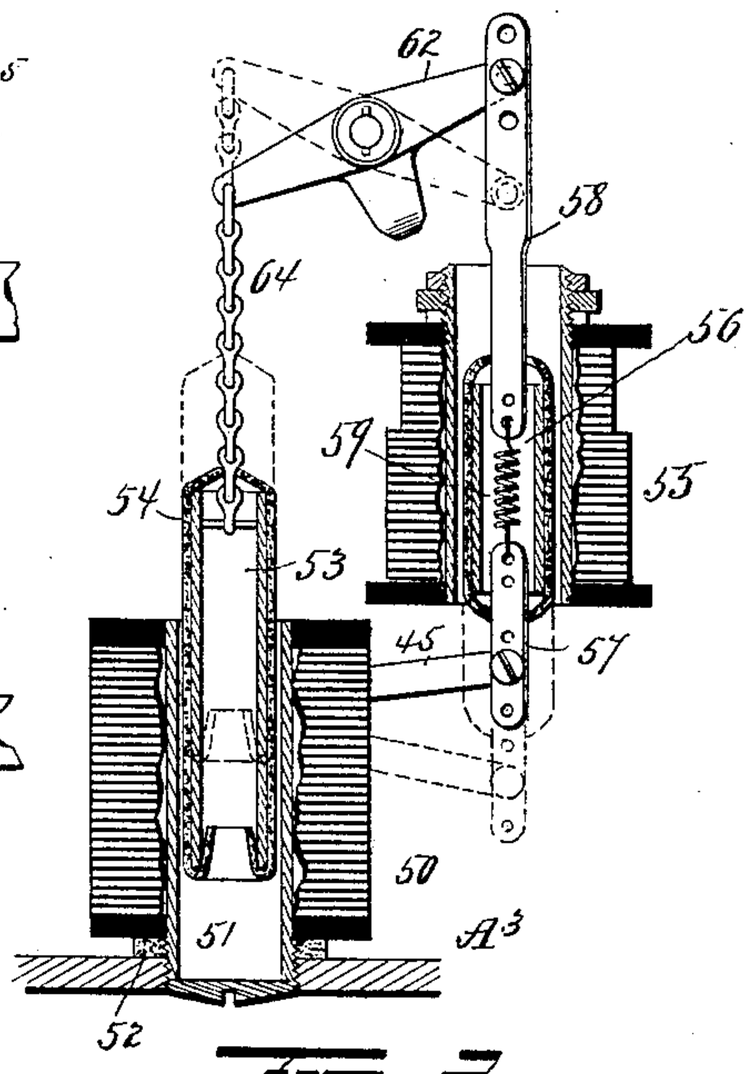
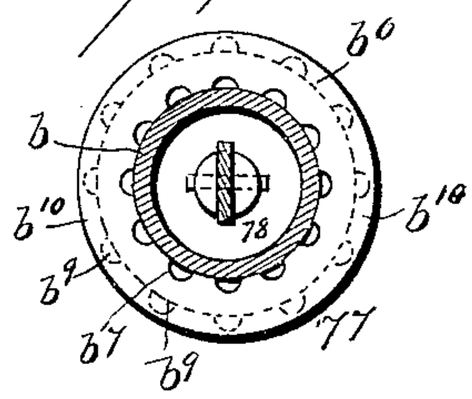


FIG. 2.

FIG. 7.



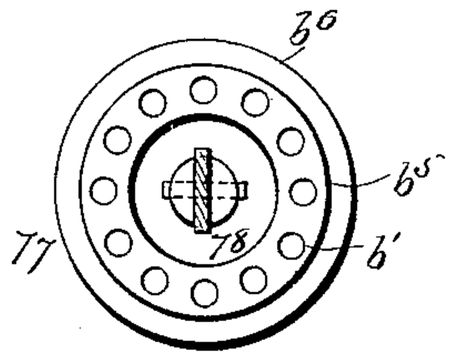
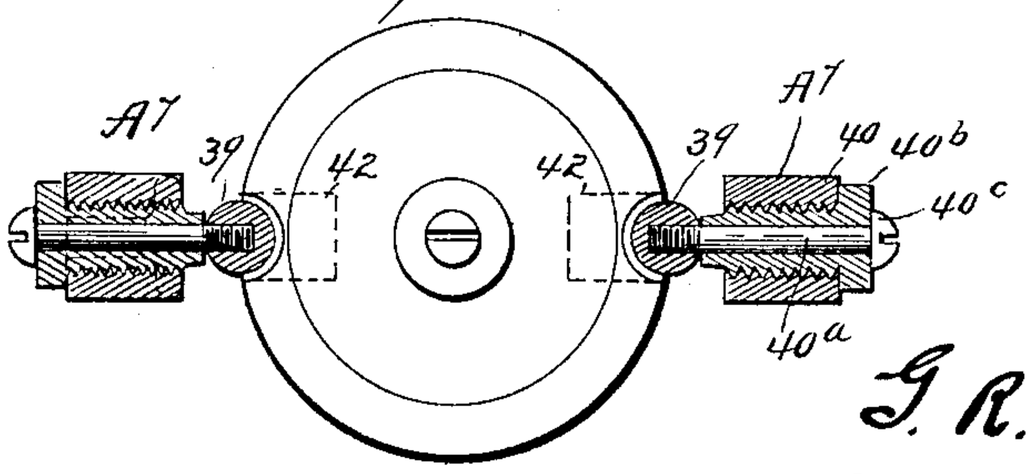


FIG. 8.

FIG. 3.

FIG. 1.

FIG. 4.



Witnesses
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(No Model.) 6 Sheets—Sheet 3.

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ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

Fig. 9.

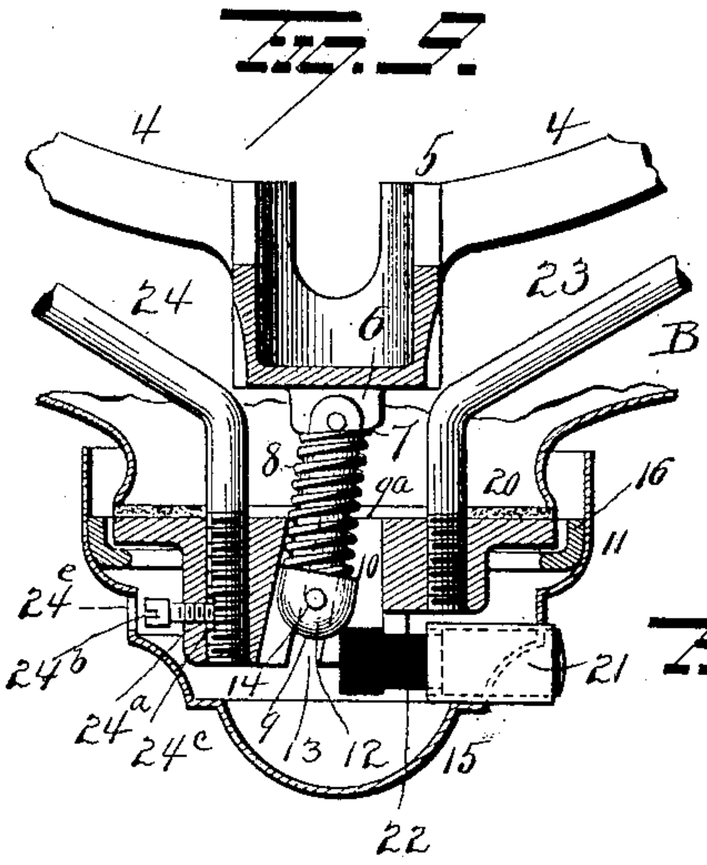


Fig. 10.

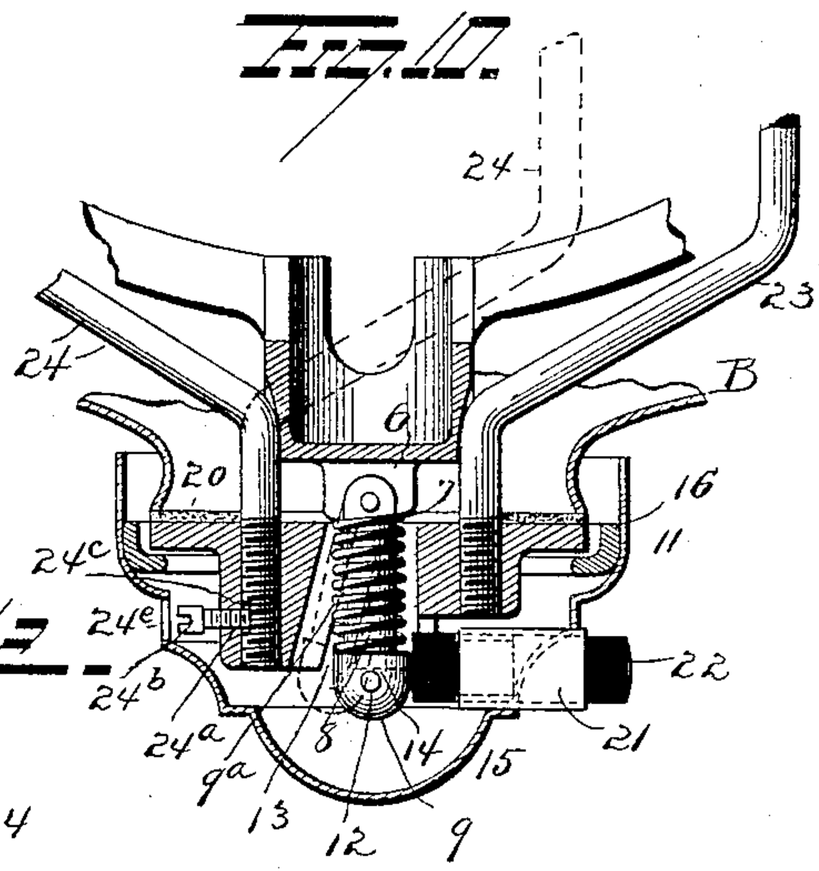


Fig. 12.

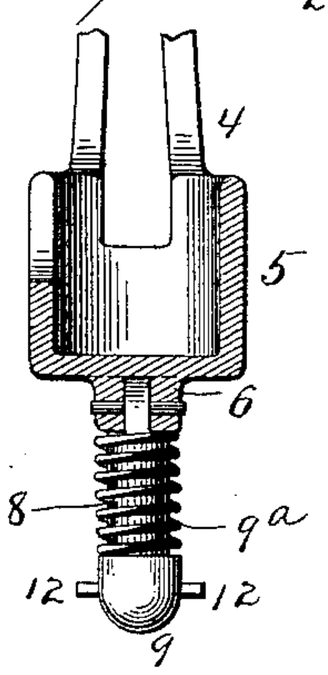


Fig. 11.

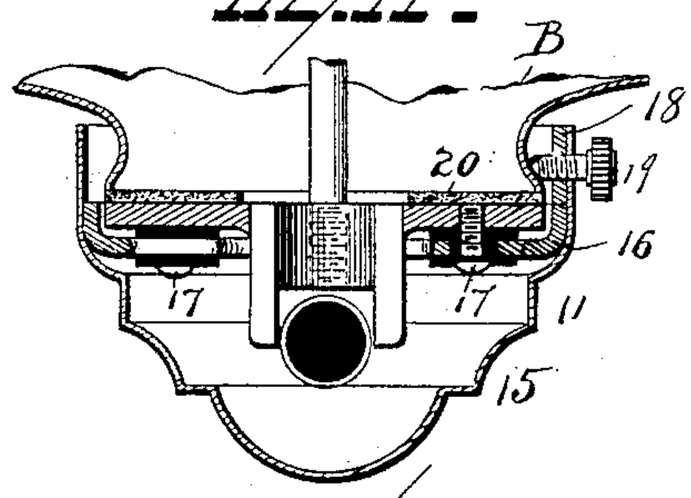
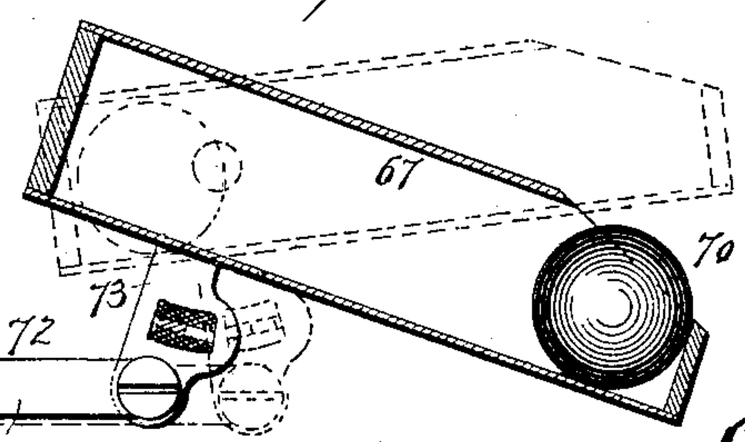


Fig. 13.



Witnesses
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(No Model.) 6 Sheets—Sheet 4.

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ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

FIG. 14.

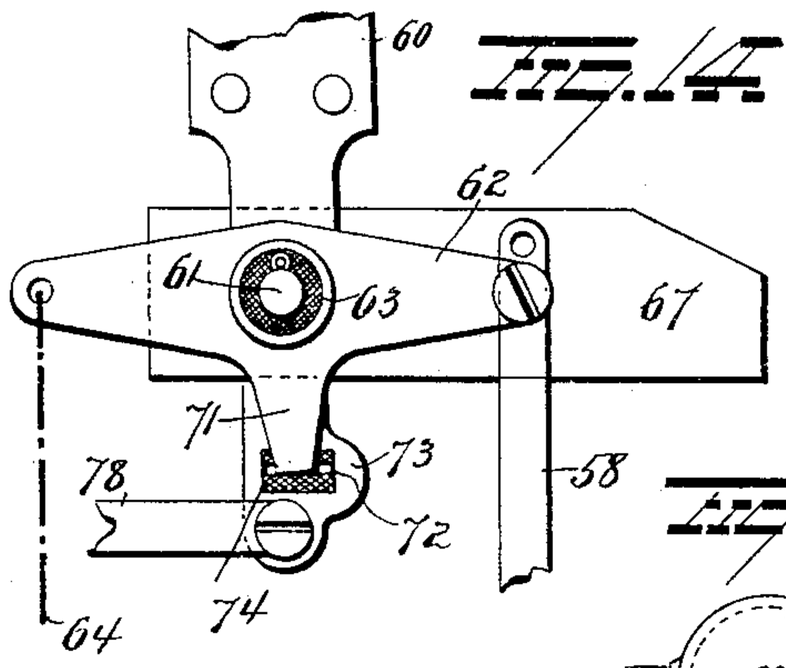


FIG. 15.

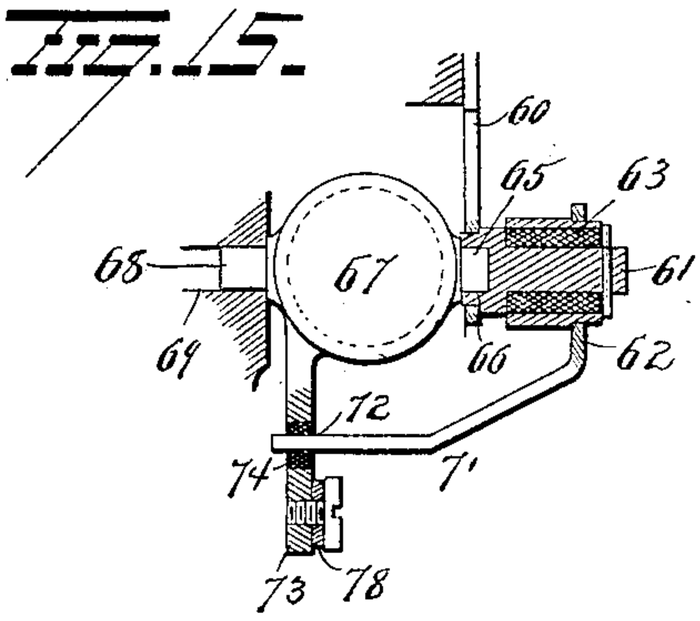


FIG. 16.

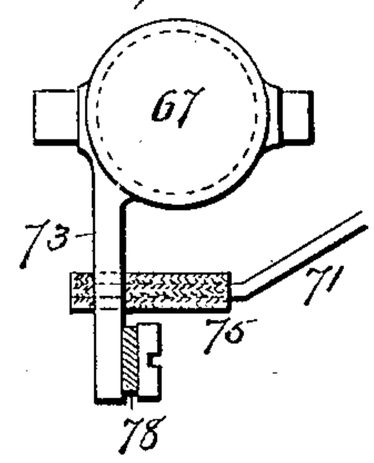


FIG. 18.

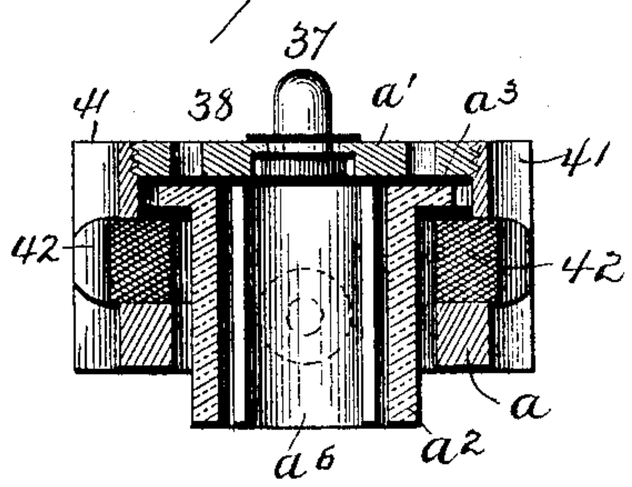


FIG. 17.

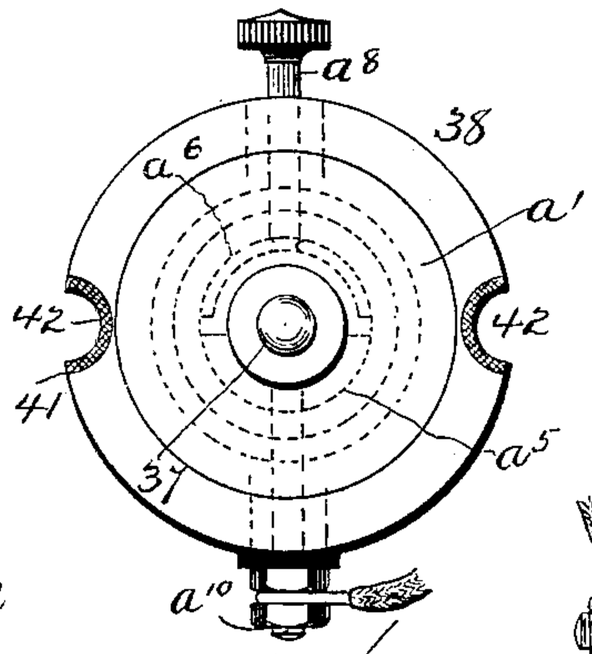


FIG. 19.

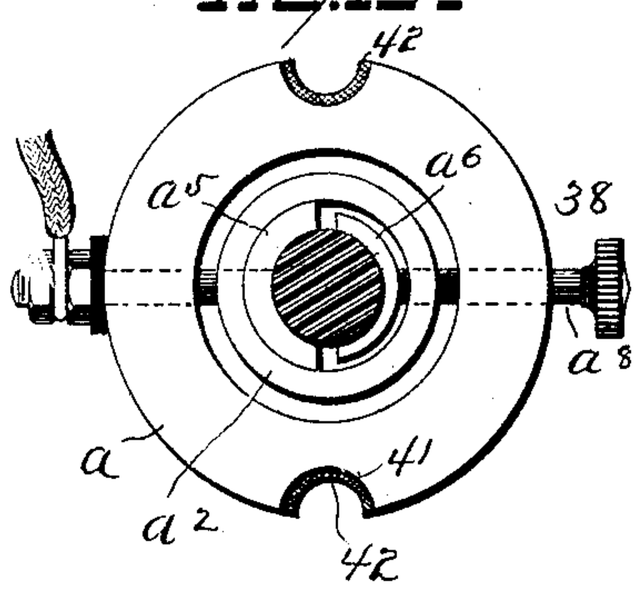
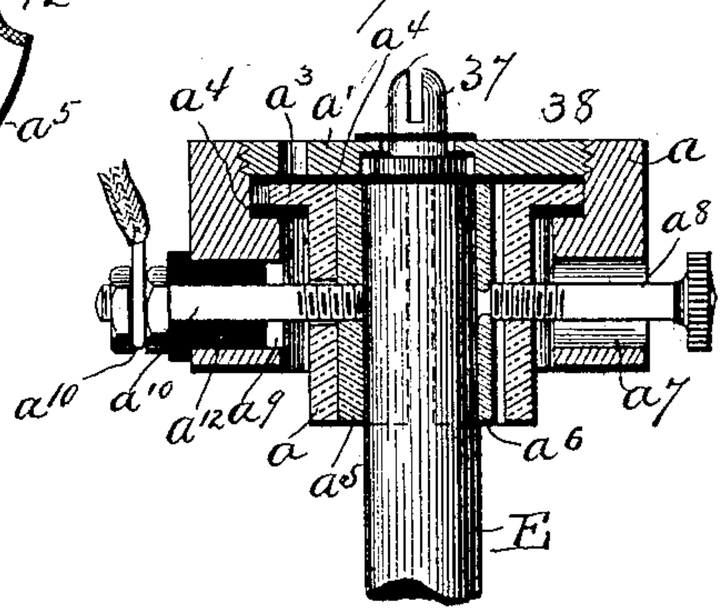


FIG. 20.



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(No Model.) 6 Sheets—Sheet 5.

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ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

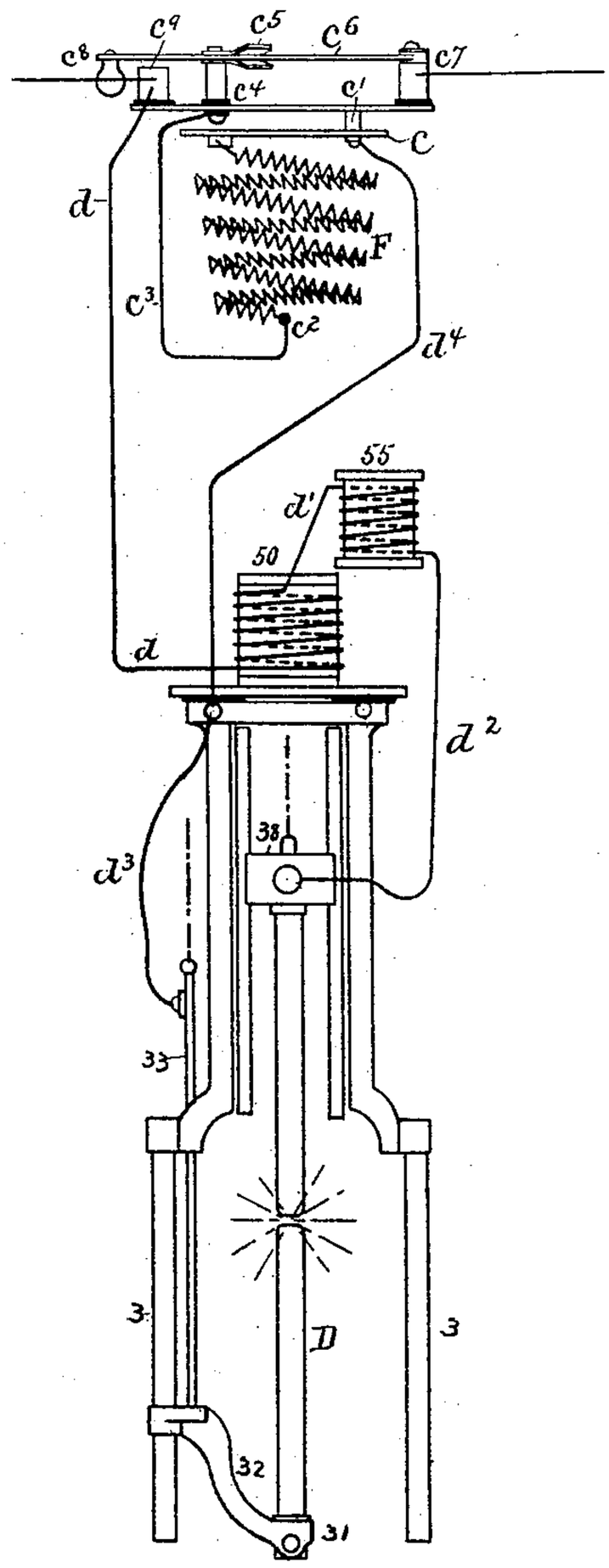

Fig. 22.

Witnesses
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(No Model.) 6 Sheets—Sheet 6.

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ELECTRIC ARC LAMP.

No. 598,942. Patented Feb. 15, 1898.

Fig. 23.

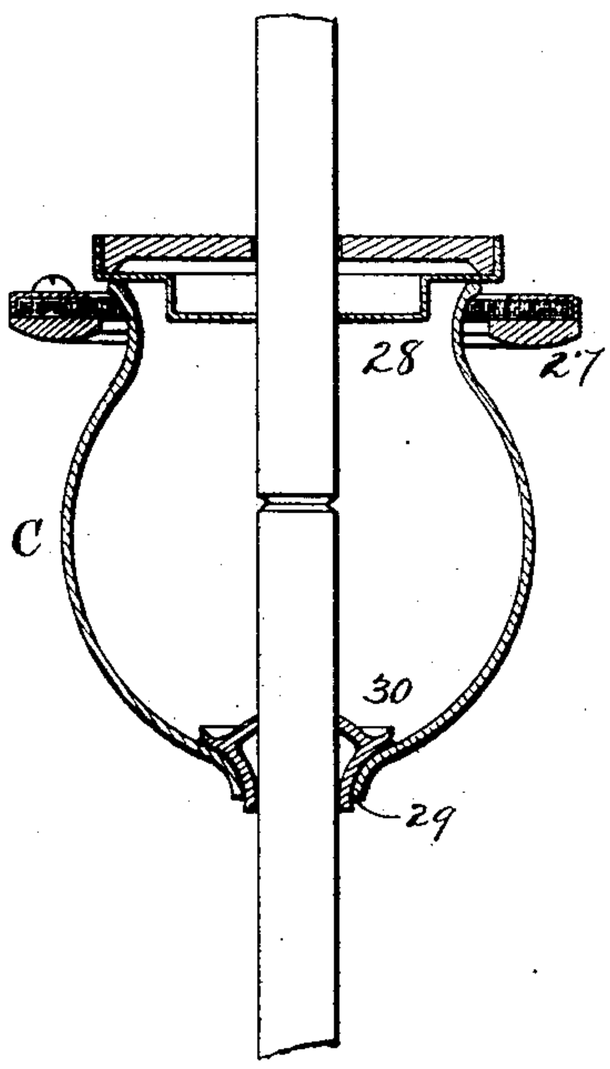
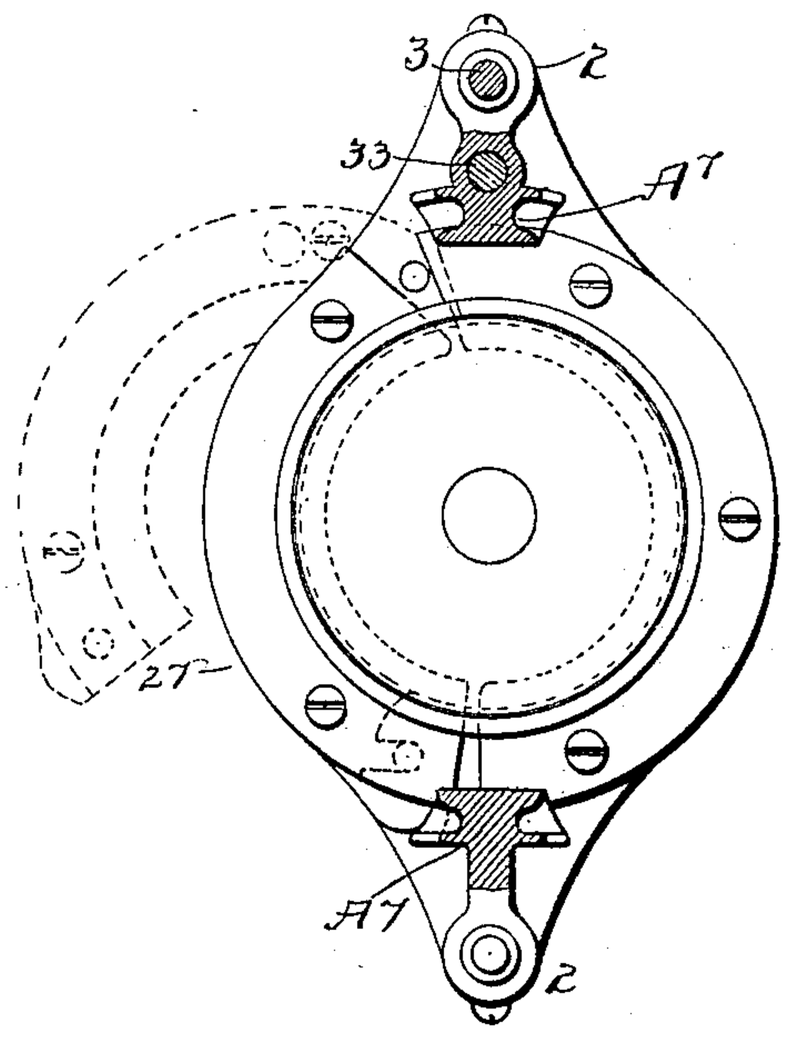


Fig. 24.



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UNITED STATES PATENT OFFICE.

GEORGE R. LEAN, OF CLEVELAND, OHIO; JOTHAM POTTER, ADMINISTRATOR OF SAID LEAN, DECEASED, ASSIGNOR TO THE JANDUS ELECTRIC COMPANY, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 598,942, dated February 15, 1898.

Application filed February 20, 1897. Serial No. 624,332. (No model.)

To all whom it may concern:

Be it known that I, GEORGE R. LEAN, a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Electric-Arc Lamps; and I do hereby 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 make and use the same.

My invention relates to an improvement in electric-arc lamps, and more particularly to such as are intended for use with alternating electric currents.

In the operation of arc-lamps with alternating currents much annoyance has been experienced on account of the clattering noise in the regulating mechanism, due to the rapid rupturing of the arc while the lamp is being started, and even greater annoyance is occasioned during the burning of the lamp by the humming and buzzing sounds which result from the rapid vibration of the parts.

The object of my invention is to obviate the defects heretofore met with in arc-lamps employing alternating currents and to so construct the lamp that in its operation noise resulting from vibration shall be reduced to a minimum.

A further object is to provide simple and efficient means whereby to effect the prompt and accurate starting of the lamp.

A further object is to provide simple appliances whereby to insure the gradual separation of the carbons of an alternating-current arc-lamp without liability of rupturing the arc.

A further object is to provide arc-starting devices which will operate effectually to draw a long arc for an alternating-current arc-inclosed electric lamp without liability of rupturing the arc before the normal or permanent arc shall have been formed.

A further object is to so construct electromagnetic devices for forming and regulating the arc of an alternating-current arc-lamp that they will be actuated promptly and positively the instant the current enters the lamp.

A further object is to construct the arc starting and regulating devices in such manner that any tendency of the magnetic reaction on account of the employment of alternating currents will be obviated.

A further object is to provide a simple, delicately-operating, and effective retarding device for the regulating or controlling mechanism of an electric-arc lamp.

A further object is to provide a retarding device which will operate sluggishly in one direction and entirely free to move quickly in the reverse direction.

A further object is to provide the controlling mechanism of an electric-arc lamp with a device which shall be so constructed that it will control the gradual formation of the arc when moved in one direction, and which shall be adapted to be moved unobstructed in the opposite direction, whereby to insure the prompt relighting of the lamp should the arc become extinguished.

A further object is to provide a simple and efficient regulator for alternating-current arc-lamps.

A further object is to provide a simple brake device for use in the regulator of an electric-arc lamp.

A further object is to provide the upper-carbon holder or cross-head of a focusing-lamp with means whereby to insure the free movement of the same without noise from vibration.

A further object is to provide a simple and inexpensive globe-holder for an arc-lamp, one which will permit the ready removal of the globe and which shall effectually perform all its functions.

With these objects in view the invention consists in the combination, in an electric-arc lamp, of a feeding-coil and a starting-coil included in series with the feeding-coil.

My invention further consists in the combination, in an alternating-current arc-lamp, of a starting-coil, a feeding-coil included in series with the starting-coil, an armature for each coil, devices connecting said armatures, and connections between one of said armatures and the carbons of the lamp.

My invention further consists in the combination, in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said

coils, and devices connected with said armatures in such manner as to normally dispose the armature of the starting-coil within the dense portion of the magnetic field of said coil and the armature of the feeding-coil to one side of the dense portion of the magnetic field of its coils.

My invention further consists in the combination, in an electric-arc lamp, of two solenoids connected together in series, the core or armature of one solenoid being normally disposed in the dense portion of the magnetic field of said solenoid and the core or armature of the other solenoid being normally disposed to one side of the dense portion of the magnetic field thereof, a rocking bar or lever, connections between the respective ends of said rocking bar or lever and said cores or armatures, and connections between one of said cores or armatures and the carbons of the lamp.

My invention further consists in the combination, in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils, connections between said armatures, and a retarder common to both armatures.

My invention further consists in the combination, in an electric-arc lamp, of a starting-coil, a feeding-coil, an armature for each coil, connections between said armatures, and a device common to both armatures constructed and adapted to retard the movement of said armatures in one direction and permit their free movement in the other direction.

My invention further consists in the combination, in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils, connections between said armatures, an air-pot, and a valved plunger in said air-pot and common to both armatures.

My invention further consists in the combination, in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils, connections between said armatures, carbons, a brake device for controlling the movements of said carbons, and connections between said brake device and one of said armatures.

My invention further consists in the combination, in an electric-arc lamp, of a controlling and regulating mechanism comprising a combined chain wheel or pulley and brake-wheel, a brake-shoe connected with the electromagnetic devices of the controlling and regulating mechanism, the electrodes, and a flexible device passing over said chain wheel or pulley and connected with said electrodes.

My invention further consists in the combination, with the depending portion of the frame of an arc-lamp and a bar pivoted thereto and depending therefrom, of a globe-holder normally supported by said pivoted arm.

My invention further consists in the combination, with the depending portion of the frame of an electric-arc lamp, a bar pivotally connected thereto and depending therefrom and pins projecting laterally from said bar, of a globe-holder having inclined slots to permit the passage of said pins, the globe-holder being constructed to be normally supported on said pins.

My invention also consists in a retarding device for the controlling and regulating mechanism of an electric-arc lamp, said retarding device comprising a cylinder and a piston, said piston being composed of a body portion having peripheral flanges at its ends, one of said flanges having perforations and a ring disposed between said flanges and neatly fitting the cylinder, said ring being of such length as to permit a slight independent movement of the body portion of the piston, whereby to cause said perforations to be opened or closed and thus control the passage of air through the piston and effect a slow movement of said piston in one direction and a quick movement in the other direction.

My invention further consists in certain other novel features of construction and combinations and arrangements of parts, as hereinafter set forth, and pointed out in the claims.

In the accompanying drawings, Figure 1 is an elevation of a lamp embodying my invention, the casing and outer globe being shown in section. Fig. 2 is an enlarged detail view showing the electromagnetic devices of the regulator. Figs. 3 and 4 are enlarged detail views of the brake device and chain wheel or pulley. Figs. 5, 6, 7, and 8 are detail views of the air-pot retarding devices. Figs. 9, 10, 11, and 12 are detail views of the globe-holder. Figs. 13 to 21 are views of various other details. Fig. 22 is a diagrammatical view. Figs. 23 and 24 are detail sectional views illustrating the arc-inclosing globe and adjacent parts.

A represents the lamp-casing, which is in effect divided into two compartments A' A^2 by means of a horizontal plate A^3, the upper compartment being intended for the reception of the regulating mechanism. The plate A^3 constitutes a part of the frame of the lamp, the upper portion A^4 of said frame being constructed to receive and support parts of the regulating mechanism and terminates at its upper end in a shank A^5, which projects above the lamp-casing and is provided at its upper extremity with a ring A^6 or similar device by which the lamp can be suspended from a suitable hanger or support. The lower portion of the lamp-frame comprises two depending arms A^7, connected at their upper ends by a curved plate A^8, secured to the horizontal plate A^3. The arms A^7 extend through the lower compartment A^2 of the casing and, projecting some distance below the same, enter the upper portion of the outer globe B. The depending arms A^7 are provided at their lower ends with laterally-projecting shoulders 1 1, having perforated bosses 2 at their free ends for the reception of depending tubular rods 3, the lower ends of which are connected together by means of a yoke 4, having a hollow enlargement 5 intermediate of its ends. The

enlargement 5 is provided on its bottom with perforated lugs 6, having beveled lower ends 7, and between these lugs a depending bar 8 is pivotally supported. The bar 8 is provided at its lower end with a head 9, against which one end of a coiled spring 9^a on the bar bears, the other end of said spring bearing against the inclined or beveled ends 7 of the lugs 6 and thus tends to move the bar 8 laterally. The bar 8 is intended to pass through an opening 10 in a globe-holder 11, and the head 9 on said bar is provided with laterally-projecting pins 12 to move in inclined slots or grooves 13, made in the wall of the opening 10. From this construction it will be seen that when the globe-holder is being moved up into position the pins 12 will pass through the slots or grooves 13 and that when said holder shall have been moved to its normal position the spring 9^a, acting against the inclined ends of the lugs 6, will cause the bar 8 to swing laterally, so as to assume a vertical position, thereby projecting the pins 12 under shoulders 14 on the globe-holder, so that said holder will be supported in its normal position on these pins. The globe-holder is inclosed and protected by a sheet-metal cap 15, secured to a ring 16, and the latter is attached to (and preferably insulated from) the body of the holder by means of screws 17. The ring 16 is provided with ears or enlargements 18 for the accommodation of thumb-screws 19, adapted to engage the lower lip of the outer globe and hold the same firmly to its seat on an insulating-washer 20 on the body of the globe-holder. The sheet-metal cap 15 may be provided with a pocket 21 for the reception of a button 22, by means of which the bar 8 can be moved so as to disengage the pins 12 from engagement with the bottom of the holder and permit the globe and its holder to be lowered. The body of the globe-holder is made with screw-threaded sockets for the reception of the screw-threaded lower ends of two rods 23 24. The wall of one of the sockets is made with a screw-threaded hole 24^a for the reception of a screw 24^b, the end of which latter enters a recess 24^c in the rod 24, whereby to normally prevent said rod from turning. When the globe is first applied to the lamp, the screw 24^b will be removed, and the rod 24 will be turned so as to approach the rod 23, Fig. 10, when both rods can be passed through the small end of the globe. The rod 24 will then be turned to its normal position and secured by screw, the cap 15 being perforated, as at 24^e, to permit the insertion of a screw-driver. I am thus enabled to use a globe-holder comprising a small number of parts to be handled in manipulating the globe. From their connection with the holder the rods 23 24 project laterally and then upwardly through the tubular rods 3, terminating some distance above the same. The rods 23 24 are notched near their upper ends to form teeth 25, which when the globe and its holder are lowered will engage rings 26, pivotally attached at the lower ends of the tubular rods 3, and thus the globe and holder will be sustained when lowered. The lower ends of the depending arms A^7 are provided with a ring 27, made in two sections hinged together and adapted to support an arc-inclosing globe C, the upper lip of said globe having a bearing on said ring. The arc-inclosing globe is provided with a cover 28 of any preferred form of construction and has a hole for the passage of the upper carbon.

The lamp herein shown and described being of the "focusing" type, in which the lower as well as the upper carbon is fed, the arc-inclosing globe is made with a hole 29 for the passage of the lower carbon D. A bushing 30 is preferably provided for the lower carbon, said bushing being mounted loosely within the bottom of the globe and adapted to have sufficient play or lateral movement therein to compensate for irregularities in the carbon.

The lower carbon is carried by a holder 31, disposed at the free end of an arm 32, adapted to have a vertical movement on one of the tubular rods 3. A rod 33 is secured to the arm 32 and extends upwardly and loosely through a boss 34 on one of the arms A^7. A chain 35 or other flexible device is attached at one end to the upper end of the rod 33 and passes over a chain wheel or pulley 36, mounted in the upper compartment of the casing, the other end of said chain or flexible device being attached to a knob or projection 37 on a cross-head 38, which latter carries the upper carbon of the lamp. The wheel 36 may comprise three disks or plates—viz., a central plate *e*, constituting a chain-wheel, and plates *f f*, at the respective sides of the plate *e*, and of greater diameter than the latter, so as to form, in effect, peripheral flanges projecting beyond the plate or wheel *e*, for a purpose hereinafter mentioned. The openings in the plates *e f f* for the passage of the journal or pintle *g* are considerably larger than the diameter of said journal or pintle for the accommodation of antifriction-rollers *h*, which will be prevented from escape by means of plates *i*, secured to the outer faces of plates *f f*. The cross-head 38 comprises an annular body portion *a*, closed at its top by a screw-threaded plate *a'*, to which the knob 37 is secured, and insulated therefrom. A sleeve a^2, having an annular flange a^3 at one end, is disposed within the annular body portion *a*, but not in contact therewith, the flange a^3, by which the sleeve is supported, being insulated from the body portion *a* and plate *a'* by means of insulating-washers a^4. The end of the upper carbon E is insulated within and held between two jaws a^5 a^6, the jaw a^5 normally resting against the inner wall of the sleeve a^2. The annular body portion of the cross-head is made with a hole a^7, through which a thumb-screw a^8 (considerably smaller than said hole) passes. The screw a^8 also passes through a screw-threaded hole in the sleeve a^2, and at its inner end said screw is

swiveled to the jaw a^6. By means of this screw the upper carbon can be firmly clamped between the jaws a^5 and a^6. The body of the cross-head is provided with a hole a^9 at a point diametrically opposite the hole a^7, through which a binding-post a^{10} passes, said binding-post also passing freely through the sleeve a^2 and entering a screw-threaded hole in the jaw a^5, whereby to conduct current to the upper or positive carbon E. The cross-head 38 forms part of the negative side of the lamp, as hereinafter more fully explained, and the binding-post a^{10} must, therefore, be insulated therefrom. For this purpose an insulating sleeve or plug a^{12}, encircling said binding-post, is inserted into the hole a^9.

The cross-head 38 is disposed between the arms a^7 or, more properly speaking, between rods or guides 39, adjustably attached to said arms by means of screws 40 and 40^a, the screws 40 being passed through screw-threaded holes in the arms A^7 and having heads 40^b to bear against said arms, and the screws 40^a are made with plain body portions to pass through holes in the screws 40, and each has one end screw-threaded to enter threaded sockets in the guide-rods 39, the heads 40^c of screws 40^a being adapted to bear against the heads 40^b of the screws 40. The cross-head 38 is made in its outer wall at points at right angles to the holes a^7 a^9 with vertical grooves 41 for the reception of the guide-rods 39. Between the ends of the grooves 41 sockets are made for the reception of blocks 42 of antifriction material, such as graphite, the outer faces of which are recessed for the reception of the guide-rods. By the use of the graphite or antifriction bearing-blocks 42 the cross-head 38 can be fitted closely between the guide-rods without interfering with the free movements of said cross-head, and thus the vibration of said cross-head and guide-rods will be avoided and assist in reducing the humming noise of the lamp.

The chain wheel or pulley 36 above alluded to is made with flanges 43, whereby to constitute it also a brake-wheel, on the journal 44 of which the bifurcated end of a lever 45 is mounted. Each arm of the bifurcated lever is provided at the pivoted end thereof with lugs or short arms 46. To the free ends of the lugs 46 the upper curved ends of links 47 are pivotally connected, said links being of sufficient length to project somewhat beyond the periphery of the combined chain and brake wheel 36. A brake-shoe 48 is pivotally mounted between the links 47 in proximity to the free ends of the latter and is adapted to engage the flanges 43 of wheel 36. The free extremities of the links 47 are adapted to engage (when the lamp is at rest or during the feeding of the carbon) a stop 49, adjustably attached to the lamp-frame. From this construction and arrangement of parts it will be seen that when the lever 45 is raised from the position shown in full lines in Fig. 3 the lugs 46, moving in the arc of a circle, will cause the links 47 to rise and the brake-shoe 48 to bite against the peripheral flanges of the wheel 36. As the upward movement of lever 45 continues the links 47 being unable to turn farther on their pivotal supports will be moved in the arc of a circle by the lever 45, and thus the wheel 36 will be turned and the chain 35 made to travel thereover, resulting in moving the carbons to separate them and establish the arc. During the feeding of the carbons (which will be more fully explained farther on) the lever 45 will descend and the links 47 be permitted to strike the stop 49, when their further movement with the lever will be prevented, and as the lever continues to descend the links will move down slightly and thus release the wheel 36.

The outer or free end of the lever 45 is connected with electromagnetic devices of the regulator which will now be described. A coil or solenoid 50 is mounted on the plate or floor A^3 and secured thereto by the screw-threaded lower end of the spool 51. A disk 52, preferably of asbestos, is disposed between the plate or floor A^3 and the bottom of the coil to take up any vibrations to which the coil might be subjected. As the mechanism of an arc-lamp operating with alternating currents is subjected to violent vibration, the core 53 of the coil or solenoid 50 is covered with asbestos 54 or similar soft material to take up vibrations of the core and drown any noise which might be produced by such vibrations. Another coil or solenoid 55, smaller (having less convolution of wire) than the coil 50, is secured to the lamp-frame, preferably above said coil 50 and insulated from said frame, asbestos or similar soft material being preferably used for or in part for such insulation, so as to take up vibration. The core 56 of coil or solenoid 55 is also inclosed in an envelop of asbestos or other soft material to take up vibrations and thus assist in obviating noise which would otherwise result from such vibrations. A short link 57 is pivotally attached to the lower end of the core 56, and to this link the lever 45 is pivoted. Another link or bar 58 is pivotally attached to the upper end of the core 56 and projects some distance above the same, the two links or bars 57 58 being connected together within the core 56 by means of a coiled spring 59, the office of which is to maintain said links or bars in close contact with their pivots and thus prevent noise from vibration.

A depending arm or bracket 60 is secured to the lamp-frame and is provided at its lower end with a pintle 61, on which an oscillatory bar or lever 62 is mounted, a bushing 63 of graphite being disposed between said bar or lever and pintle, whereby to permit free oscillatory or rocking movement of the bar or lever and at the same time prevent the same from vibrating or rattling during the operation of the lamp. To one end of the rock-

ing or oscillatory bar or lever the link 58 is pivotally connected, and to the other end of said bar or lever one end of a chain 64 is attached, the other end of said chain being attached to the upper end of the core 53 of coil or solenoid 50. Experience has shown that if the chain 64 be made of magnetic metal the vibration and humming thereof would be very great, and I propose, therefore, to make said chain of some non-magnetic material and thus materially reduce the humming vibrations.

It has been found in practice that when a solenoid is energized by an alternating electric current the core will first be drawn to the dense part of the magnetic field, and then, on account of magnetic reaction on the core due to the alternations of the current, the core will tend to retract or rebound and move out of the dense portion of the field. In other words, the core of the solenoid is liable to vibrate more or less violently before it will be retained permanently in the dense portion of the magnet-field of the coil. For this reason the use of a single solenoid in an electric-arc lamp with which an alternating electric current is employed will result in the defective starting of the lamp, especially with a lamp of the arc-inclosed type in which a long arc is drawn and maintained. Such vibrations of the core of the solenoid will not only delay the establishment of the normal arc, but will cause violent vibrations of the component parts of the regulator, with consequent wear and noise. To avoid these most annoying and disastrous defects encountered in electric-arc lamps, I employ a second solenoid 55 to effect the starting of the lamp, the solenoid 50 being employed to regulate the feed of the carbons. The solenoids 50 and 55 are connected in series with each other, but the latter contains fewer convolutions of wire than the former and is consequently capable of exerting a weaker pull on its core.

The strongest part of each solenoid energized by an alternating current will be about two-thirds way through the coil, and the cores are normally disposed relatively to these points. When the lamp is idle, the core 53 of coil 50 will be disposed in a weak portion of the coil just above or to one side of the strongest magnetic point in the coil, while the core 56 of coil 55 will be normally disposed in the strongest magnetic point of its coil. It is apparent, therefore, that when current first enters the lamp the core 56, being already in the strongest part of the magnetic field of the coil 55, will be promptly and positively actuated and, moving up into a weaker part of the coil, will turn the rocking bar or lever 62 on its fulcrum, so as to permit the core 53 to promptly enter the strongest part of coil 50, where it will remain. The combined action of the two solenoids will result in a long pull on the lever 45 and the consequent wide separation of the carbons. When the carbons shall have been separated and the arc established, the core 56 will be in a weak part of its coil and the core 53 will be in the strong part of the solenoid 50, and as the solenoid 50 is the more powerful of the two and overbalances the starting-solenoid the feeding of the carbons will be controlled by said solenoid 50.

It is a matter of importance that the arc be drawn gradually in order to avoid possibility of rupture before the normal arc shall have been established, and for this purpose the devices now to be described will be employed. The lower end of the arm or bracket 60, hereinbefore referred to, is made with a socket 65 to form a bearing for one of the trunnions 66 of a rocking tube or trough 67 for the reception of a ball or weight 70, the other trunnion 68 of said tube or trough being mounted in a socket or bearing 69 in the lamp-frame. The trunnions 66 68 project from the tube or trough 67 at points between the center thereof and its rear end, so that when the lamp is being started the ball or weight 70 will exert its maximum resistance to the operation of the mechanism and thus assist in retarding the separation of the carbons. For this purpose the tube or trough is connected with the rocking or oscillatory bar or lever 62 by means of a curved or angular arm 71, which projects from the pivoted central portion of said rocking bar or lever 62 and enters an elongated slot 72 in an arm 73, which projects downwardly from the pivoted portion of the tube or trough 67. In order to prevent undue vibration in the connection between the arms 71 73, the slot 72 may be lined with graphite 74 or other anti-friction material which will serve to make a close fit between these parts without interfering with their free movement relatively to each other. Instead of lining the slot 73 with graphite the end of the arm 71 which enters said slot may be covered with asbestos, (shown at 75, Fig. 16,) or, if desired, the arm 71 may be provided with a sleeve or covering of graphite.

The main retarder for the regulator consists of an air-pot comprising the pot or cylinder 76 and a plunger 77 of peculiar construction, the rod 78, attached to said plunger, being connected with the arm 73. The plunger 77 is so designed that it will offer considerable resistance when moved in one direction and so that it will offer no resistance when moved in the other direction. In constructing the plunger 77 I employ a cup-shaped body portion b, having an outwardly-projecting peripheral flange b^5 at its open end, and said flange is made with a number of perforations b'. A plate b^2 is secured to the closed end of the cup-shaped body portion b of the plunger by means of a screw b^3, and is made of such size as to project beyond the outer face of said body portion b, so as to form in effect a peripheral flange b^4. The screw b^3 is made with a bifurcated head for the reception of the plunger-rod 78. The body of the plunger is of such size that the peripheral flanges b^4 b^5

will be disposed a short distance from the interior wall of the cylinder 76, and between said peripheral flanges a sleeve b^6, of graphite, is disposed, the length of said sleeve being slightly less than the distance between the peripheral flanges b^4 b^5, so that the body portion of the plunger can have a slight movement independently of the sleeve b^6 for a purpose presently explained. The graphite sleeve has a close but sliding fit within the cylinder 76 and is made interiorly with a series of longitudinal grooves or ducts b^7. The forward end of the graphite sleeve is recessed to form a seat b^8 for the plate b^2, or, more properly speaking, for the peripheral flange b^4 of said plate, whereby to close the longitudinal grooves or ducts b^7 when the plunger is moved in one direction, and thus retard or offer resistance to the movement of said plunger in that direction. When the plunger-rod is moved in the other direction, the body of the plunger will first move independently of the graphite sleeve, so as to move the plate b^2 away from its seat and uncover the ends of the grooves or ducts b^7, thus permitting a free access of air through said grooves or ducts and the perforations b' in the peripheral flange b^5, the entrance of air to said grooves or ducts being augmented by a series of notches b^9 in the flange b^{10} at the forward end of the graphite sleeve. Thus it will be seen that while the graphite sleeve fits comparatively close within the cylinder 76, still its lubricating quality will permit it to move without liability of binding and that when the plunger is pulled outwardly the air-ducts will be automatically closed and the resistance offered will be such as to retard the movement of said plunger. When, however, the plunger is pushed in the opposite direction, the air-ducts will be promptly and automatically opened by the movement of the body b independently of the sleeve b^6 and the forward movement of the plunger will be perfectly free and unretarded. The air-pot retarder is therefore very sensitive and prompt in the performance of its function of retarding the movement of parts connected therewith under certain conditions or permitting their free movement under other conditions.

As the lamp will be employed on a constant-potential circuit a resistance-coil F will be provided, and this resistance can be conveniently inclosed within a housing 78, formed by the upper part of the lamp-casing. The resistance-wire is coiled on a series of bars 79^a, disposed in conical form within the housing 78 and supported by plates or rings 79 and 80, secured to the shank A^5 of the lamp-frame. One end of the resistance-coil is connected with a plate c, to which a binding-post c' is attached. The other end of the resistance-coil is connected with a binding-post c^2 on the plate or ring 80, and said binding-post c^2 is electrically connected by means of a conductor c^3 with a post c^4, located on the plate or ring 79. The post c^4 supports contact-fingers c^5 of a manual cut-out switch, the switch-arm c^6 being pivotally connected to the negative terminal or binding-post c^7 of the lamp and provided at its free end with an insulated knob c^8.

A metal disk c^{10} is disposed above the rheostat and serves to prevent heat arising from the rheostat from coming in contact with the ceiling of the room when the lamp is hung close to it.

The circuits through the lamp may be traced as follows: Starting with the positive binding-post c^9, the current will flow through a conductor d to and through the feeding-coil 50, then by conductor d' to starting-coil 55, through said coil 55, and then by conductor d^2 to the positive carbon E, then to and through the lower carbon to the lower-carbon holder, then up through the lower portion of the lamp-frame and a conductor d^3 to the plate A^8, then through said plate, then by conductor d^4 to binding-post c', then through plate c to the resistance-coil, then through said resistance-coil to the binding-post c^2, then by conductor c^3 to the switch-post c^4, and then through switch-arm c^6 to the negative terminal c^7 of the lamp.

The operation of the lamp is as follows: When no current is flowing through the lamp, the carbons are normally in contact. If the switch-arm c^6 be now moved into contact with the contact-fingers of the cut-out, current will enter and flow through the lamp and energize both coils 50 and 55. The core 53 of solenoid 50 being normally disposed in a weak part of the coil, it will be drawn toward the strongest part and will be prevented from jumping or rebounding on account of the magnetic reaction caused by the alternating current employed by the action of the starting-coil 55, as above explained, the core of said latter coil being normally disposed in the strongest part thereof, so that when the current first enters the lamp the solenoids will commence to exert a long pull on their cores, the result of which will be to turn the rocking bar or lever 62 on its fulcrum. During the first part of the movement of the rocking arm or lever the free end of the arm 71 will move from one end to the other of the elongated slot 72 in arm 73, and the core of the starting-solenoid will move sufficiently to apply the brake-shoe to the wheel 36 and turn the latter, so as to begin the separation of the carbons and form a very small arc between them. The cores of the solenoids and the rocking bar or lever 62 will continue to move; but their movement and the consequent separation of the carbons will now be retarded by the action of the plunger 77 in the cylinder, and the separation of the carbons will be further retarded by the effort of the tube or trough 67 to turn and raise the ball or weight 70 therein. Thus the carbons will be gradually pulled apart and the long arc of an arc-inclosed lamp will be drawn gradually and without danger of rupture. During the for-

mation of the arc the end of the tube or trough 67, containing the ball or weight 70, will gradually rise until the arc shall have been drawn nearly to its full length, when the ball 70 will roll to the opposite end of said tube or trough, causing the same to assume the reverse inclination as shown in Fig. 13 and completing the establishment of the full arc. The core 53 of the feeding-solenoid 50 has now reached its extreme working position in the strongest part of said solenoid, as shown in full lines in Fig. 2, and the core 56 is in its extreme position in a weak part of coil or solenoid 55. The feed of the carbons will therefore be mostly under the control of the solenoid 50, and the proper feed of the carbons will be accomplished without disturbing the position of the tube or trough 67 (shown by dotted lines in Fig. 13) by the play allowed the arm 71 in the elongated slot 72 in arm 73.

When the lamp is open-circuited by the switch above described and the light thus extinguished, the cores of the solenoids will be released and the tube or trough 67 permitted to turn on its fulcrum, whereupon the ball 71 will roll down to the outer end of said tube or trough and cause the latter to assume the position shown in full lines in Fig. 13. This action of the tube or trough 67 and the ball or weight 71 will cause the plunger 77 to be forced back to the extreme end of the cylinder 76, the plunger being permitted to move quickly and freely to this position by the automatic valve action therein, as above explained. The lamp is now in position to be again started in the same manner as above explained, when the switch is again closed.

In the construction of my improved lamp it is desirable to pack every pivotal or movable connection with asbestos, graphite, or other material, whereby to prevent noise from vibration.

Various changes might be made in the details of construction of my invention without departing from the spirit thereof or limiting its scope, and hence I do not wish to limit myself to the precise details herein set forth.

Practical test has demonstrated that my improvements are effectual in all respects in the performance of their functions.

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

1. The combination in an electric-arc lamp constructed to operate with alternating electric currents, of a starting-coil, a feeding-coil, the feeding-coil included in series with the starting-coil, an armature for each coil, said armature being normally so disposed relatively to the magnetic fields of the respective coils, that the armature of the starting-coil will be actuated in advance of the armature of the feeding-coil, devices connecting said armatures and connections between one of said armatures and the carbons of the lamp, substantially as set forth.

2. The combination in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils connected with each other in such manner as to normally dispose the armature of the starting-coil within the dense portion of the magnetic field of its coil, and the armature of the feeding-coil to one side of the dense portion of the magnetic field of its coil, substantially as set forth.

3. The combination in an electric-arc lamp, of two solenoids connected together in series, the core or armature of one solenoid being normally disposed in the dense portion of the field of said solenoid and the core or armature of the other solenoid being normally disposed to one side of the dense portion of the magnetic field thereof, a rocking bar or lever, connections between the respective ends of said rocking bar or lever and said cores or armatures and connections between one of said armatures and the carbons of the lamp, substantially as set forth.

4. In an electric-arc lamp, the combination with the carbons and clutch mechanism, of a starting-coil, a feeding-coil arranged in series with the starting-coil and with the carbons, armatures for said coils mechanically connected together and so disposed relatively to their respective coils that one coil will balance the other during the feeding of the lamp, and connections between said armatures and clutch mechanism, substantially as set forth.

5. In an electric-arc lamp, the combination with the carbons and clutch mechanism, of a starting-coil, a feeding-coil, an armature for each coil, said armatures being so disposed relatively to their respective coils that during the feeding action of the lamp, the armature of the feeding-coil will occupy a stronger portion of the field of said coil than the portion of the field of the starting-coil occupied by the armature of the latter, and connections between said armatures and the clutch mechanism, substantially as set forth.

6. The combination in an electric-arc lamp, of a starting-coil, an armature therefor, links pivotally attached to the respective ends of said armature, a spring connecting said links, a retarder connected with one link and clutch mechanism connected with the other link, substantially as set forth.

7. In an electric-arc lamp, the combination with a starting-coil, a feeding-coil, a rocking bar and cores or armatures for said coils, of a flexible connection between the core or armature of the feeding-coil and one end of said rocking bar, a cross-head, a link connecting said cross-head and the core or armature of the starting-coil, a clutch and a connection between said clutch and the core or armature of the starting-coil, substantially as set forth.

8. In an electric-arc lamp, the combination with a starting-coil, a feeding-coil, a rocking bar and cores or armatures for said coils, of a flexible connection between one end of said rocking bar and the core or armature of the feeding-magnet, a link connecting the other end of the rocking bar and the core or arma-

ture of starting-coil, another link connected to said last-mentioned core or armature, a spring connecting said links, a clutch and a connection between said clutch and one of said links, substantially as set forth.

9. In an electric-arc lamp, the combination with a starting-coil, a feeding-coil and armatures for said coils, the armature of the starting-coil being normally disposed in a strong portion of the magnetic field thereof, and the armature of the feeding-coil being normally disposed outside of the strongest portion of the magnetic field of said feeding-coil, said armatures being constructed and arranged to move simultaneously in opposite directions, of a clutch device connected with one of said armatures and a retarder connected with both of said armatures, substantially as set forth.

10. The combination in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils arranged to be moved simultaneously in opposite directions, the armature of the starting-coil disposed to be normally in the strong part of the magnetic field thereof, and the armature of the feeding-coil disposed to be normally outside of the strongest part of the magnetic field of said feeding-coil, connections between said armatures and a retarder between and common to both of said armatures, substantially as set forth.

11. The combination in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils arranged to be moved simultaneously in opposite directions, the armature of the starting-coil disposed to be normally in the strong part of the magnetic field thereof and the armature of the feeding-coil disposed to be normally outside of the strongest part of the magnetic field of said feeding-coil, connections between said armatures and a device common to both armatures, constructed and adapted to retard the movement of said armatures in one direction and permit their free movement in the other direction, substantially as set forth.

12. The combination in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils arranged to be moved simultaneously in opposite directions, the armature of the starting-coil disposed to be normally in the strong part of the magnetic field thereof and the armature of the feeding-coil disposed to be normally outside of the strong part of the magnetic field of said feeding-coil, connections between said armatures, an air-pot and a valved plunger in said air-pot and common to both armatures, substantially as set forth.

13. The combination with the regulator of an electric-arc lamp, of a retarder connected therewith, said retarder comprising a body portion having a perforated flange at one end, a sleeve loosely encircling said body portion and having air-ducts in its inner face, and a disk secured to said body portion and adapted to close said ducts when the plunger is moved in one direction, the relation between said sleeve and the disk and flange of the body portion being such as to permit the body portion to have a limited movement independent of the sleeve, whereby to cause the air-ducts to be opened when the plunger is moved in one direction and closed when it is moved in the other direction, substantially as set forth.

14. A retarder for an electric-arc-lamp regulator, consisting of a cylinder closed at one end and a plunger therein, said plunger having air-ducts and comprising a body portion and a graphite sleeve encircling said body portion, said body portion adapted to have a movement independently of said sleeve, whereby to cause the air-ducts to be automatically opened or closed when the plunger is moved in one direction or the other, substantially as set forth.

15. A retarder for an electric-arc-lamp regulator, consisting of a cylinder closed at one end and a plunger therein, said plunger comprising a body portion having peripheral flanges at its ends, one of said flanges having openings therein, a graphite sleeve encircling said body portion so as to permit the body portion to have a longitudinal movement in the sleeve, limited by said peripheral flanges, and air-ducts in said graphite sleeve, substantially as set forth.

16. The combination in an electric-arc lamp constructed to operate with alternating currents, of a starting-coil and a feeding-coil arranged in series with each other, armatures for said coils, said armatures being normally so disposed relatively to the magnetic fields of the respective coils, that the armature of the starting-coil will be actuated in advance of the armature of the feeding-coil, devices connecting said armatures, a friction-brake, and a connection between the shoe of said brake and one of said armatures, substantially as set forth.

17. The combination in an electric-arc lamp, of a starting-coil, a feeding-coil, armatures for said coils, a rocking bar, connections between one end of said rocking bar and the armature of the starting-magnet, connections between the other end of said rocking bar and the armature of the feeding-magnet, an arm projecting from said rocking bar, a retarder, and a movable connection between said retarder and the arm on the rocking bar, substantially as set forth.

18. The combination in an electric-arc lamp, of a magnet, a rocking bar to which the armature of said magnet is connected, an arm projecting from said rocking bar, a retarder, a pivoted arm with which the plunger of the retarder is connected, said pivoted arm having an elongated slot for the reception of the free end of the arm on the rocking bar and a packing between said last-mentioned arm and the walls of the slot in the pivoted arm, whereby to prevent noise from vibration between said arms, substantially as set forth.

19. The combination in an electric-arc lamp, of a magnet, a rocking bar connected with the

armature of said magnet, a clutch device also connected with the armature of said magnet, a tube or trough pivotally supported between its ends, a ball or weight in said tube or trough, and a connection between said rocking bar and said tube or trough, substantially as set forth.

20. The combination in an electric-arc lamp, of a magnet, a rocking bar connected with the armature of said magnet, a clutch device also connected with the armature of said magnet, a tube or trough pivotally supported between its ends, an arm projecting from said tube or trough, a connection between said arm and the rocking bar, a retarder and a connection between said retarder and the arm on the pivoted tube or trough, substantially as set forth.

21. In an electric-arc lamp, the combination with the frame, and a magnet, of a bracket secured to said frame, said bracket having a pintle and a socket at its free end, a tube or trough pivotally supported in said socket and in the lamp-frame, a rocking bar mounted on said pintle, a graphite bushing interposed between said pintle and rocking bar, a connection between said rocking bar and the armature of the magnet, and a connection between said rocking bar and the pivoted tube or trough, substantially as set forth.

22. In an electric-arc lamp, the combination with a frame and movable carbon-holders, of a wheel, a flexible device connecting said carbon-holders and passing over said wheel, a pivoted lever having lugs projecting upwardly therefrom, links having curved upper ends pivoted to said lugs and depending below the pivot of the lever, a brake-shoe pivoted between said links and adapted to engage the periphery of said wheel, a stop to insure the disengagement of the brake from said wheel, and electrically-controlled devices connected with said pivoted lever, substantially as set forth.

23. In an electric-arc lamp, the combination with a frame and movable carbon-holders, of a combined chain wheel or pulley and brake-wheel mounted on a pintle projecting from the framework, said wheel comprising three disks, the outer disks being of greater diameter than the intermediate disk, whereby to form peripheral flanges, rollers between said disks and the pintle on which the wheel is mounted and plates secured to the outer disks for retaining said rollers in position, a flexible device connecting said carbon-holders and passing over the central disk of said wheel, a brake to engage the peripheral flanges of said wheel, and electrically-controlled devices connected with said brake, substantially as set forth.

24. In an electric-arc lamp, the combination with the frame, arms depending therefrom and a wheel mounted in the framework above said arms, of guide-rods disposed alongside said arms, screws passing transversely through said arms and supporting said guide-rods, a cross-head disposed between said guide-rods and adapted to carry the upper carbon, a lower-carbon holder and a flexible device connected with said carbon-holder and cross-head and passing over said wheel, substantially as set forth.

25. In an electric-arc lamp, the combination with depending arms having transverse screw-threaded holes, hollow screws passing through said holes, guide-rods disposed parallel with said depending arms, pins or screws passing freely through said hollow screws and entering screw-threaded sockets in said guide-rods, and a vertically-movable cross-head disposed between said guide-rods and adapted to constitute a holder for the upper carbon, substantially as set forth.

26. In an electric-arc lamp, the combination with depending arms, of a vertically-movable cross-head mounted between said depending arms and constituting part of the negative side of the lamp, said cross-head comprising a hollow body portion, and a sleeve located therein and insulated therefrom, two jaws disposed within said sleeve for the reception of the positive carbon, a binding-post electrically connected with one of said jaws and insulated from the body of the cross-head, and a thumb-screw passing through said sleeve and swiveled to the other jaw located therein, substantially as set forth.

27. In an arc-inclosed focusing electric-arc lamp, the combination with the framework, and means for feeding both carbons simultaneously, of a divided plate, an arc-inclosing globe supported by said plate and having openings in both ends, a cover closing the upper end of the globe and having a hole for the passage of the upper carbon, and a bushing mounted loosely in the bottom of the globe for the accommodation of the lower carbon, substantially as set forth.

28. In an electric-arc lamp the combination with the lamp-frame and tubular extensions depending therefrom, of a globe-holder, rods secured to said globe-holder and passing through said tubular extensions, each rod having a tooth at or near the upper ends of said rods, and rings loosely attached below the lower ends of said tubular extensions so as to be engaged by said teeth when the globe-holder is lowered, whereby to support said globe-holder and the globe attached thereto, when they are lowered, substantially as set forth.

29. In an electric-arc lamp, the combination with the depending portion of the frame, of a depending bar pivoted to the frame to swing laterally, a spring on said bar to maintain it in a normally vertical position and a globe-holder detachably supported by said pivoted bar, substantially as set forth.

30. In an electric-arc lamp, the combination with the depending portion of the frame, a bar pivoted to the lower end thereof and pins projecting laterally from said bar, of a globe-holder having inclined slots to permit the

passage of said pins, the globe-holder being constructed to be normally supported on said pins, substantially as set forth.

31. In an electric-arc lamp, the combination with the depending portion of the frame, and a bar pivoted to the lower end thereof, of a globe-holder having an opening for the passage of said bar and having inclined slots communicating with said opening, pins projecting from said bar to pass through said slots and engage the bottom of the holder and a spring disposed between the free end of said bar and its pivotal support, substantially as set forth.

32. In an electric-arc lamp, the combination with the depending portion of the frame, of lugs projecting from the lower end thereof and having inclined ends, a bar pivoted to said lugs, and having a shoulder at or near its free end, a globe-holder having an opening for the passage of said bar and having inclined slots or grooves communicating with said opening, pins projecting from said bar adapted to pass through said slots or grooves, and a spring located on said bar, one end of said spring bearing against the shoulder in the bar and the other end bearing against the inclined ends of the lugs whereby to force the pins under the bottom of the holder when the globe-holder shall have been moved to its normal position, substantially as set forth.

33. In an electric-arc lamp, the combination with the frame and depending tubular extensions, of a bar pivoted to the lower end of the frame, a globe-holder having an opening for the passage of said bar and having inclined slots communicating with said opening, pins on said bar to pass through said slots and become disposed under the globe-holder, rods secured at their lower ends to said globe-holder and passing through said tubular extensions of the frame, and means for preventing the escape of said rods from the tubular extensions when the globe and its holder are lowered, substantially as set forth.

34. In an electric-arc lamp, the combination with the depending portion of the frame, and inclined lugs at the lower end thereof, of a bar pivoted to said lugs, and having a head at its free end, pins projecting laterally from said head, a globe-holder having an opening for the passage of said bar and having inclined slots for the passage of said pins, a spring on said bar, said spring bearing at one end against the head on the bar and at the other end against the inclined ends of the lugs on the frame, whereby to cause the pins to be disposed under the globe-holder, a cap inclosing said globe-holding devices and a button mounted in said cap, for moving the pivoted bar so that the pins will aline with said inclined slots when globe and its holder are to be lowered, substantially as set forth.

35. In an electric-arc lamp, the combination with the frame, of a globe-holder consisting of a body portion adapted to be attached to the frame, a ring secured to said body portion of the globe-holder, perforated lugs projecting from said ring, thumb-screws passing through said lugs and adapted to engage the globe, and a cap connected with said ring and inclosing the globe-holder, substantially as set forth.

36. In an electric-arc lamp, the combination with the carbon-holders, a magnet and an armature for said magnet, of a clutch device for the carbons, a tilting way connected with the clutch device, a movable weight supported by said way and a connection having lost motion or play between said tilting way and said armature, substantially as set forth.

37. In an electric-arc lamp the combination with the carbon-holders, a solenoid, and a movable core or armature for said solenoid, of a clutch device for the carbons connected with one end of said core or armature, a tilting way, a weight movable on said tilting way, and a connection between said tilting way and the other end of the core or armature of said solenoid, substantially as set forth.

38. In an arc-inclosed focusing arc-lamp, the combination with the framework, and the carbons, of an arc-inclosing globe provided at one end with a cover having an opening in which one of the carbons snugly fits and through which it is fed, and a bushing surrounding said carbon and passing through said opening and a flange on said bushing resting loosely on the inner face of the globe, substantially as set forth.

39. In an electric-arc lamp, the combination with the depending portion of the frame, and a bar pivoted to the lower end thereof, of a globe-holder normally supported by said pivoted bar, a cap inclosing said globe-holder and a button mounted in said cap for disengaging said pivoted bar from said globe-holder, substantially as set forth.

40. In an electric-arc lamp, the combination with a frame and tubular extensions depending therefrom, of a globe-holder adapted to be detached from the frame for the reception of the globe, crank-shaped rods to slide in said tubular extensions and connected to the globe-holder, the attachment of one of said rods to the globe-holder being movable whereby it can be made to approach the other rod and thus permit said rods to be simultaneously passed through the openings in the end of the globe, and a locking device for maintaining said movable rod in position to pass through one of said tubular extensions, substantially as set forth.

41. In an electric-arc lamp, the combination with a frame, tubular extensions depending therefrom, and a globe having a contracted opening in its lower end, of a holder for said globe, two rods adapted to pass through said tubular extensions, each rod having a crank-shaped lower end connected to the globe-holder, one permanently and the other movably, the movable rod having a recess, and a set-screw in the globe-holder and entering said recess whereby to retain said movable

rod in its normal position relatively to the other rod and the tubular extensions which said movable rod enters, substantially as set forth.

42. In an arc-lamp, the combination with its carbons and means for feeding them simultaneously and thereby maintaining the arc at a fixed point, of an arc-inclosed globe provided at each of its ends with a cover having an opening through which one of the carbons is fed and within which it snugly fits, the parts being constructed to permit of the lateral adjustment of the openings through which the carbons are fed, substantially as set forth.

43. In an electric-arc lamp, the combination with a frame, a globe having a contracted opening in its end and tubular extensions depending from said frame, of a globe-holder and rods having crank-arms at their lower ends attached to said globe-holder and passing through said tubular extensions, the connection of one of said rods to the globe-holder being adjustable, whereby said rods can be made to approach each other and thus permit them to be passed simultaneously through the contracted opening in the globe, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

GEORGE R. LEAN.

Witnesses:
J. M. SEE,
SHELDON CARY.