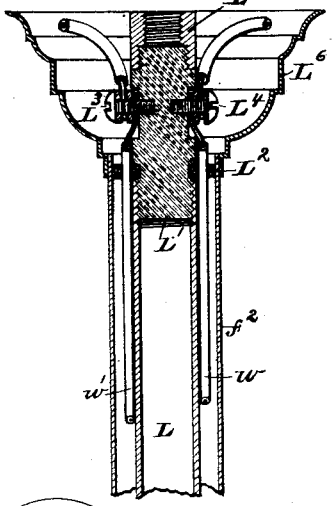
(No Model.) 3 Sheets—Sheet 1.

W. JANDUS.

ELECTRIC ARC LAMP.

No. 513,111. Patented Jan. 23, 1894.

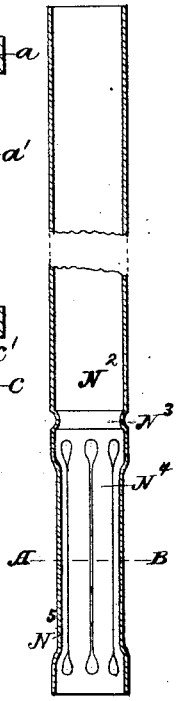
-FIG. II-



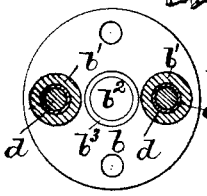
-FIG. I-

-FIG. XVI-

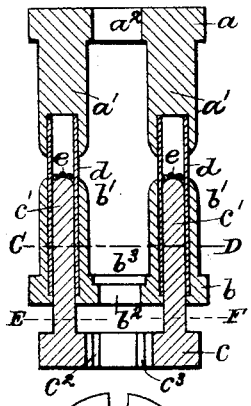
-FIG. III-



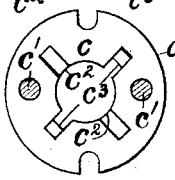
-FIG. IVa-



-FIG. IV-

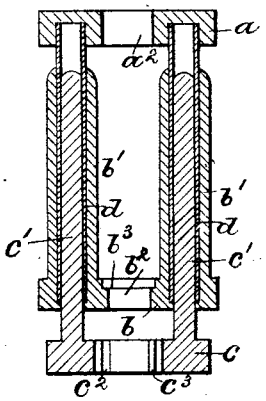


-FIG. IVb-



-FIG. III a-

-FIG. XV-



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ATTORNEYS.

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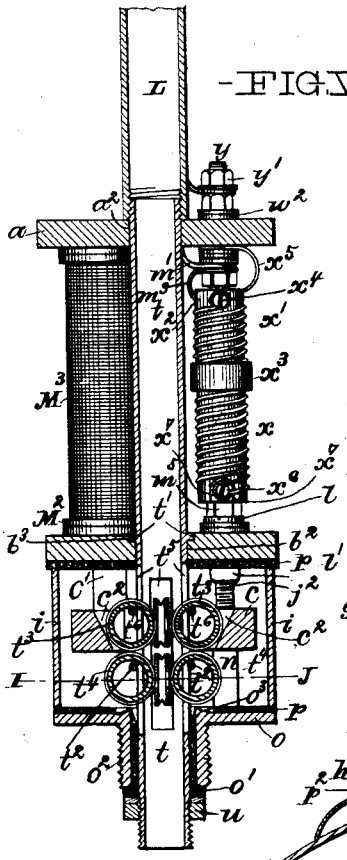
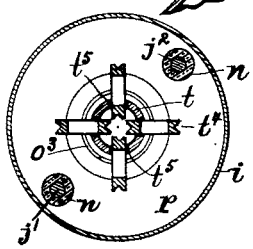
ELECTRIC ARC LAMP.

No. 513,111. Patented Jan. 23, 1894.

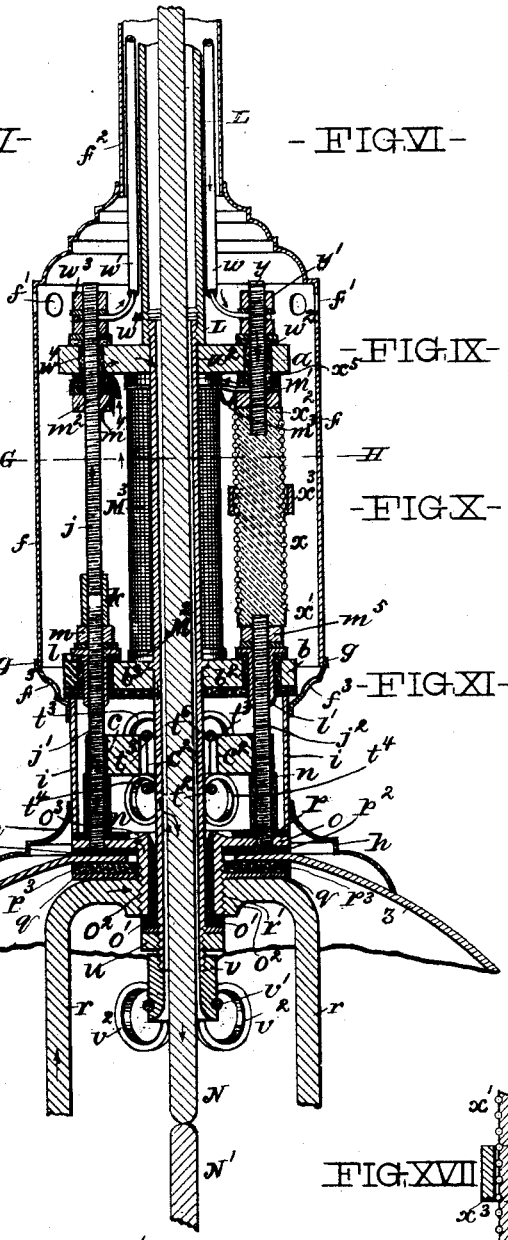
-FIG.V-



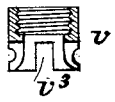
-FIG.V-a



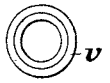
-FIG.VI-



-FIG.IX-



-FIG.X-



-FIG.XI-

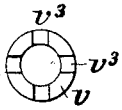
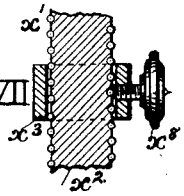
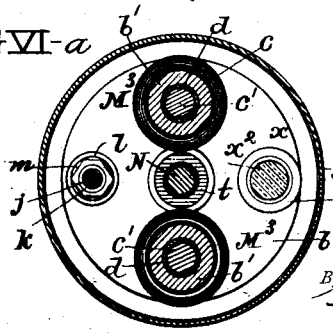


FIG.XVII



-FIG.VI-a



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ELECTRIC ARC LAMP.

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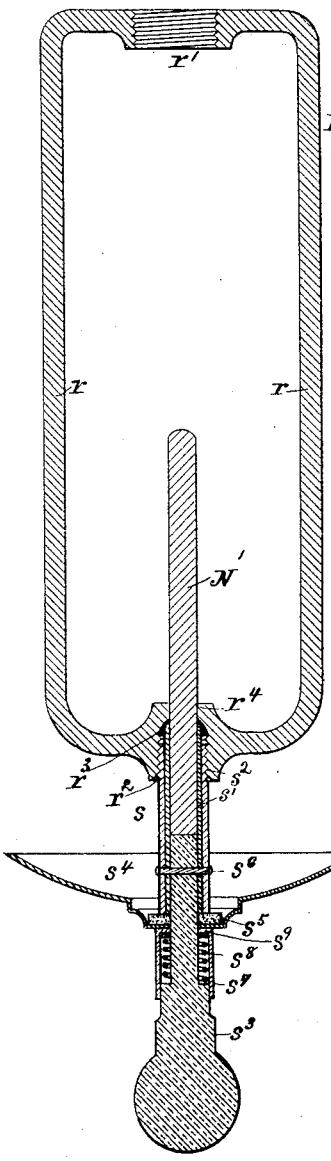
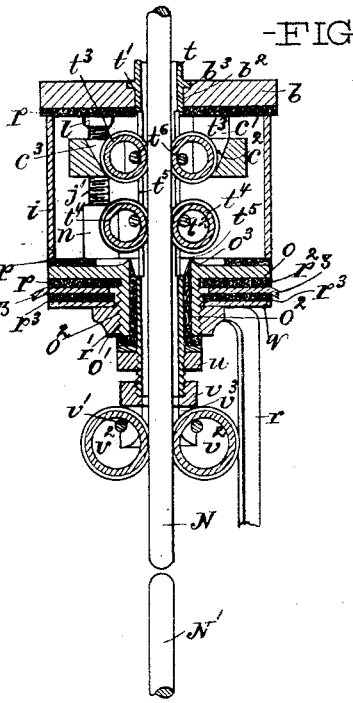
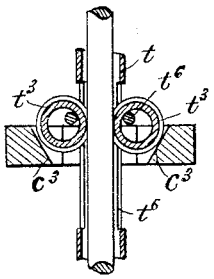
-FIG. VII-



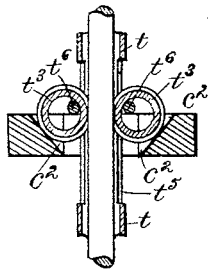
-FIG. VIII-



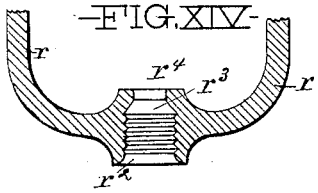
-FIG. XVIII-



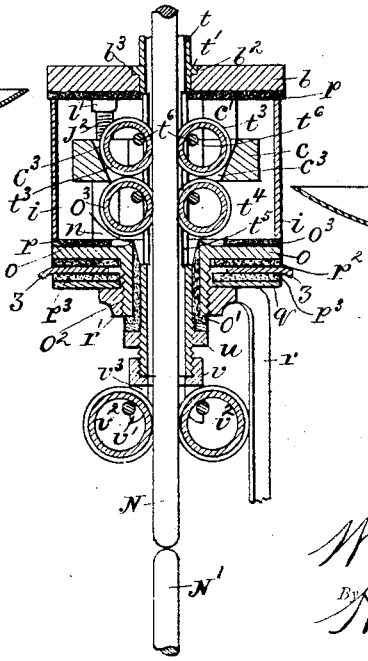
-FIG. XIX-



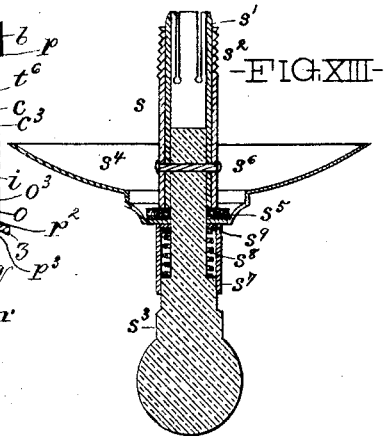
-FIG. XIV-



-FIG. XII-



-FIG. XIII-



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ATTORNEYS.

THE NATIONAL LITHOGRAPHING COMPANY.
WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

WILLIAM JANDUS, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-HALF TO JOHN B. BARTON, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 513,111, dated January 23, 1894.

Application filed October 22, 1892. Serial No. 449,614. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM JANDUS, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The annexed drawings and the following description set forth in detail, one mechanical form embodying the invention; such detail construction being but one of various mechanical forms in which the principal of the invention may be used.

In said annexed drawings—Figure I represents a vertical section of my improved electric arc lamp; Fig. II, an enlarged sectional detail view of the upper end of the tubes which support the lamp; Fig. III, a section of the auxiliary carbon holding tube; Fig. III^a, a cross section of the same on the line A—B, Fig. III; Fig. IV, a section of the magnets and the movable armature; Fig. IV^a, a cross section on the line C—D, Fig. IV; Fig. IV^b, a cross section on the line E—F, Fig. IV; Fig. V, a vertical sectional detail view of the carbon feeding mechanism; Fig. V^a, a cross section on the line I—J, Fig. V; Fig. VI, a vertical section of the carbon feeding mechanism, the surrounding casing for the same, and the upper portion of the globe; Fig. VI^a, a cross section on the line G—H, Fig. VI; Fig. VII, a section of the support for the negative carbon; Figs. VIII and XII, sectional detail views of the clutch mechanism, respectively showing the positive carbon clutched and raised to form the arc, and in its position of release; Figs. IX, X and XI, respectively a section, a top, and a bottom view of the collar for the lower brushes; Figs. XIII and XIV sectional detail views of the negative carbon holder and the lower end of the carbon supporting frame; Figs. XV and XVI, sections of two other forms of magnets; Fig. XVII, a sectional detail view of another form of cut-off sleeve for the shortcircuiting device, and Figs. XVIII and XIX, sectional detail views of the movable armature and the clutch rings, the sections being made at right angles to each other.

The lamp illustrated in the drawings is a hanging lamp or lamp destined to be supported from above. An insulating plug, L′, has a threaded socket, L^5, secured upon its upper end, by means of which socket the lamp may be secured pending from the ceiling of a room or from other elevated support. A supporting tube L is screwed with its upper end to the lower end of the insulating plug, and clamps an insulating disk, L^2, between its upper end and a shoulder upon the plug. The ends of the conductors of a supply circuit are secured to a negative binding screw, L^3, and a positive binding screw, L^4; and the ends of the negative terminal conductor, w', and positive terminal conductor, w, are secured in contact with said line conductors by means of said binding screws. The lower end of the supporting tube L is screwed upon the upper end of a carbon-containing tube t, upon the upper portion of which a disk, a, having a central aperture, a^2, is secured by said central aperture. The disk a is of soft iron and forms a portion of the upper magnet, having limbs, a', projecting downward. A similar disk, b, of the lower magnet, is secured to the carbon-containing tube t, by means of a flange, t', fitting into a rabbet, b^3, in the central opening, b^2, of the lower magnet disk; or said disk may be brazed or otherwise secured to the tube. The lower magnet disk has upwardly projecting limbs, b', and said limbs have axial bores, corresponding to similar bores in the limbs of the upper magnet. The bores of the lower magnet extend entirely through the limbs, while the bores in the limbs of the upper magnet extend only partly through said limbs. Tubes, d, of brass are secured in the bores of the magnet limbs and in airtight engagement therewith; their lower ends resting upon shoulders formed in the lower ends of the lower bores, so as to make continuous and smooth bores through the limbs. The ends of the limbs of the two magnets are at a predetermined distance from each other,—such distance being determined by the length of the interior brass tubes,—so as to produce a con-

densed magnetic field between the ends of the magnet limbs; the said field being fixed and adjusted according to the length of pull required or the length of travel of the armature cores.

The series and shunt coils are wound in the usual manner, but in such directions that all of the several poles of the magnets will be in magnetic series. Said term, viz.—magnetic series, is employed for the magnets as analogous to the term "series" when employed to describe the arrangement of electric generating or translating devices, viz.—with their poles opposed to other poles of opposite polarities or denominations; so that the north pole of one magnet is opposed to the south pole of the other magnet and the south pole of said first-named magnet is opposed to the north pole of the second magnet. The magnets are consequently in magnetic series, and the magnetic circuit in the magnets will be completed when the armature is so attracted that it closes the magnetic gaps between the poles of the magnets.

I prefer to wind the series coil, M, upon the lower magnet, and the shunt coil, M′, upon the upper magnet, as illustrated in Fig. II, but may employ compound winding, as illustrated at M^3, in Figs. V and VI, in which the compound coil is shown as wound upon spools, M^2. In either case, the upper magnet serves, so to speak, as a stationary armature to the lower magnet, and vice versa; the magnetic circuit being completed through the gaps between the poles, where the field is powerfully condensed. The same condensation of the field may be obtained by simply forming the stationary armature in the shape of a bar or disk supported at the desired distance from the ends of the magnet limbs by the brass lining tubes, as illustrated in Figs. XV and XVI. In the form illustrated in Fig. XV, the limbs of the movable armature are long, and extend through the entire length of the limbs of the magnet; and in the form illustrated in Fig. XVI, the limbs of the movable armature are short and extend through the stationary armature into the ends of the magnet limbs. In either case the magnetic circuit finds a path, from one pole to the other, through the stationary armature and the field is condensed at the points between the poles of the magnet and the opposite poles of the stationary armature. This condensation of the field is of great importance as it enables me to operate the movable armature and the carbon clutch with a comparatively small number of ampère turns of wire in the coils, obviating the use of levers and other power multiplying devices for producing a strong differential effect. The magnetic field is highly condensed within the gaps between the opposed poles of opposite denominations of the two magnets, and the cores of the armature do not close the magnetic circuit until completely drawn up into the gap so as to be within the bores of the upper magnet. The strong pull caused by this arrangement of magnets in magnetic series and with gaps between all of the opposed poles of opposite denominations, is entirely dependent upon said gaps within which the magnetic force is condensed. The gaps are absolutely essential to the operation of this style of magnet; as it destroys or is detrimental to the efficiency of the magnet to close the magnetic circuit before the armature arrives at the end of its attracted position, when it simply acts as a keeper, uniting the two magnets into one. A circular armature disk, *c*, has two upwardly-projecting cores, *c′*, and has a central aperture for the carbon containing tube, from which aperture slots, c^2 and c^3, radiate; said slots having their outer ends beveled to face upward, and the slots c^2 having the bevels at a greater angle to the sides of the central eperture than the slots c^3. Small metallic bodies, *e*, of spherical shape, such as shot, are placed in the brass tubes, at the ends of the armature cores, so as to always insure metallic contact. The lower end of the positive terminal conductor *w* is secured, by means of a nut *y′*, to a screwthreaded binding post, *y*, which latter is secured in the upper magnet disk *a* and insulated from the same by means of a non-conducting sleeve, w^2; and the current passes through said binding post to the terminal, *m′*, of the series coil, M, which terminal is secured to the binding post by a suitable nut. The series coil is wound upon both magnet limbs, and its other terminal, m^2, is in contact with the upper disk, *a*, conveying the current through said disk to the carbon-containing tube *t*. Said terminal m^2 is held to the disk by a flange upon the lower end of an insulating sleeve, w^4, and by a suitable nut upon a screwthreaded rod, *j*, which forms a part of the negative conductor within the lamp, the terminal being thus insulated from said rod, which is also insulated from the disk by passing through the insulating sleeve. The negative terminal conductor *w′* is attached to said negative conductor rod by means of a binding nut w^3. The terminals, m^3 and m^4, of the shunt coil, M′, are clamped and connected to the positive and negative terminals, across the arc. A shortcircuiting device, *x*, is connected across the terminals of the series coil, and is formed by a wire, *x′*, doubled into the form of a loop having parallel limbs, and wound in parallel strands around an insulating post, x^2, secured at its upper end upon the lower end of the positive binding post *y*. The doubled, lower end of the looped wire is secured to the post by means of a screw, x^6, screwed into a countersink, x^7, in the post. The length of the shortcircuiting device and, consequently, the degree of the resistance in the same may be varied by means of an internally screwthreaded metallic sleeve, x^3, having parallel threads cut in it to engage the parallel limbs of the wire, so as to be moved up or down upon the coil and thus shortcircuit it at any desired point.

One terminal of the shortcircuiting device is secured to the post by a screw, x^4, which is in contact with the positive binding post y,—or one terminal of the series coil,—and the other terminal x^5 of the shortcircuiting device is secured against and in contact with the upper disk a,—or the other terminal of the series coil,—by means of the lower binding screw upon the positive binding post y; being insulated from the latter by the insulating sleeve w^2.

Instead of employing the screwthreaded sleeve x^3, a plain sleeve may be used, as illustrated in Fig. XVII, said sleeve having a set screw, x^8, by means of which the sleeve may be brought into metallic contact with different portions of the wire x', effecting a shortcircuit at any desired point. The degree of the resistance of the shortcircuiting device may thus be adjusted by sliding the sleeve, up or down, according to whether the resistance is to be decreased or increased, and this adjustable shortcircuiting coil will be perfectly certain in its operation and will occupy but a small space in the lamp. The lower end of the negative conductor rod j is coupled,—by means of a coupling sleeve, k,—to a rod, j', which passes through a metallic sleeve, l, inserted through the lower magnet disk b, but insulated from the same by means of a suitable insulating sleeve. The lower end of said rod is secured in a disk, o, which forms a part of the negative conductor within the lamp. A nut, m fits upon the rod j', and said nut and rod form one of the supports for the disk o. A corresponding rod, j^3, has its lower end secured in the disk o; passes up through a metallic sleeve, l',—inserted through the lower magnet disk and insulated from the same,—and enters the lower end of the insulating post for the shortcircuiting device. A nut, m^5, upon this rod, above the lower magnet disk, serves to support the disk o, similar to the nut m. This rod j^2 and its sleeve l' form,—together with disk o and the rod j', sleeve l, and rod j,—a part of the negative terminal conductor within the lamp. The disk o has a downwardly projecting, screwthreaded neck, o^2, within which an insulating sleeve or packing, o', is secured; said sleeve insulating the negative disk from the positive carbon-containing tube t. An oblong carbon-supporting frame, r, is secured with a screwthreaded opening, r', in its upper end to the screwthreaded neck o^2, and said frame has a screwthreaded opening, r^2, in its lower end, formed with an upwardly contracted, smooth portion, r^3, which terminates in a smooth and straight opening, r^4, of a diameter sufficient to admit a carbon pencil of the greatest diameter capable of use in the lamp. A lower, negative carbon holder, s, has a screwthreaded sleeve, s^2, which may fit into the lower screwthreaded opening of the carbon-supporting frame, and has a tube, s', secured inside said sleeve; said tube having its upper end slightly beveled and having longitudinal slits in its upper portion, which admits of the tube being contracted at its upper end to clamp the carbon, when the carbon holder is screwed up into the lower opening of the carbon-supporting frame. An insulating handle, s^3, is secured in the lower end of the carbon-holder by means of a rivet or pin, s^6, inserted through the outer screwthreaded sleeve, the slitted tube, and the end of the handle. A cup-shaped pan, s^4, is fitted around the handle, to slide upon the same, beneath the lower ends of the tube and sleeve, and is insulated from said tube and sleeve by an insulating washer, s^5. A spring, s^8, is coiled around the handle, and bears against a shoulder upon the same with its lower end, and said spring is inclosed by a sliding sleeve, s^7, having an inward flange, s^9, at its upper end, which rests upon the upper end of the spring, and bears against the pan. The carbon-containing tube t has longitudinal slots, t^5, and two rings, t^6 and t^2, are suitably secured, one above the other, around the slotted portion of the tube. Rings, t^3,—having grooved peripheries to engage the carbon, and forming radial clutches for the same,—are hung upon supporting ring t^6, and have play in the upper portions of the slots, and in the radial slots c^2 and c^3 of the armature. Similar rings, t^4, forming the upper radial brushes, are hung,—to have play in the lower portions of the slots,—upon the lower supporting ring t^2. The disk o has an up-turned edge or flange, o^3, around its central opening, and the upper radial brush rings t^4 may have contact with said flange when the carbon is removed. A nut, u, is fitted upon the lower screwthreaded portion of the carbon-containing tube t, and serves to rigidly clamp a casing, i, between the disk o and lower magnet disk b securely binding together the lamp structure on the central tube t. A collar, v, is secured upon the lower end of the carbon-containing tube, and is formed in its lower end with slots, v^3, in which lower brush rings, v^2, have play, said rings being supported by a ring, v', secured to the collar. A casing, i, is clamped between the lower magnet disk b and the negative disk o, said disks being drawn together by the nut u, and asbestus rings or similar insulating rings, p, are interposed between the under side of the lower magnet disk and the upper edge of said casing, and between the upper side of the negative terminal disk o and the lower edge of the casing so as to form an airtight, insulating and non-combustible packing for the chamber formed by the parts and inclosing the armature and clutch device. Insulating sleeves, n, are secured upon the rods j', and j^2, serving as stops upon which the armature may rest when lowered. The edge of the upper opening in the globe, z, is clamped between the negative disk o and the carbon frame r; insulating asbestus washers, p^2 and p^3, being interposed, as well as a metallic washer, q, be-

tween the carbon frame and the lower washer p^3, which serves to stiffen and support said washer. The upper portion of the globe is thus closed air-tight. The edge of the pan bears against the lower opening in the globe. A collar, *h*, surrounds the lower end of the airtight chamber *i*, and rests upon the top of the globe. A collar, f^3, having openings formed in it, is secured upon the upper portion of the airtight casing *i*, and has a flange, *g*, into which the lower end of a cylindrical casing, *f*, fits. The upper portion of said cylindrical casing is formed with air holes, f'. The upper end of the cylindrical casing *f* is contracted, and the lower end of a tube, f^2, is secured to said contracted end. This tube f^2 surrounds the tube L; and a canopy, L^6, is secured to the upper end of said outer tube f^2, and surrounds the socket at the end of the inner tube L and the binding screws.

A positive carbon-holding tube, N^2, may be used to lengthen the life of the positive carbon, and said tube has a slightly contracted, long socket portion, N^5, at its lower end into which the carbon may be inserted; said socket portion having longitudinal slits, N^4, which render the socket elastic. The upper end of the elastic socket is formed with an inwardly projecting bead, N^3, which serves as a stop for the end of the carbon.

The positive carbon is lettered N, and the negative carbon is lettered N', in the drawings.

If desired, the binding post connections at the upper end of the supporting tube L and its surrounding tube, may be dispensed with, and the terminal conductors may extend at the upper ends of the tubes L and f^2, through the insulating plug, where they may be suitably connected to the circuit wires.

The carbons are inserted into the lamp by unscrewing the lower carbon-holder from the threaded opening in the carbon-supporting frame. The removal of the carbon holder and pan admits of the inside of the globe, as well as the carbon-supporting frame and other parts within the globe being cleaned; the lower opening of the globe affording ample room for the insertion of the hand and a cloth or other cleaning means. The positive carbon may now be inserted through the opening in the lower end of the carbon-supporting frame, the upper, contracted portion of said opening admitting a carbon of the greatest diameter capable of use in the lamp, but preventing the insertion of a carbon of a greater diameter than what will enter the radial brushes and clutches. The end of the carbon, as it passes up through the lower brushes, will push said brushes outward and will push them out of contact with the up-turned rim of the negative terminal disk *o*, whereupon the carbon pushes the clutch rings out, and is in position to be held by the same when the current is turned on and the armature is drawn up. The negative carbon is placed in the slitted tube of the carbon-holder, and will be clamped when the latter is screwed in place. As the negative carbon is pushed upward with the holder, the positive carbon will be pushed up into its containing tube. The positive carbon will have three supports,—the clutch rings, the upper brush-rings, and the lower brush rings,—and will always be well centered, irrespective of any minor irregularities in the shape of the carbon. The brushes and clutches will, on account of their form,—being shaped as rings,—have a yielding contact with the carbon, such contact being partly rolling and partly sliding. When the carbons are secured and the current is turned on, the current will pass through the positive conductor and the positive binding post, through the series coil, and to the upper magnet plate *a* from which it will pass into the carbon containing tube to the positive carbon, passing through the brushes and clutch. From the positive carbon it passes through the negative carbon, through the carbon-holder and carbon-supporting frame to the negative terminal disk *o*, through said disk to the negative terminal rods *j'* and *j*, and to the negative conductor. The circuit being completed, the series coil energizes the magnets which attract the movable armature. The latter draws the clutch rings upward, and forces them against the carbon, as the beveled ends of the slots in the armature strike upward; the arc is formed, and the lamp is in operation. The clutch rings in the radial slots c^2 will first engage the carbon with a slight clutch, when the armature is drawn upward, on account of the longer and less steep incline of the bevels of said slots; and the clutch rings in the slots c^3 will next engage the carbon with a stronger clutch, on account of the steeper incline of the bevels of said slots, so that the armature will gradually raise the carbon and form the arc. When the armature is lowered, a similar gradual release of the carbon may take place, corresponding to the gradual clutch of the carbon by the attracted armature; the clutches which are engaged by the steep inclines releasing the carbon, whereupon the clutches engaged by the less steep inclines will allow the carbon to drop, exerting, however, a braking influence upon the carbon, as they revolve upon the inclines. When the positive carbon has been consumed so that its upper end falls below the clutches and cannot be held by the same, the current will first pass freely through the carbons, energizing the magnets so that they draw the movable armature upward in contact with the cut-out sleeves *l* and *l'*; forming the circuit through the armature, the cut-out sleeves and the negative terminal rods, and short-circuiting it from the electrodes. This cut-out will consequently be through the series coil and by the series coil. If the current should be turned on while no positive carbon is in the lamp, the primary contact will be through the lower brushes, which hang down in contact with the up-

turned flange of the negative terminal disk *o*, and thus complete the circuit through the series coil; causing the latter to raise the armature and establish the cut-out through the sleeves *l* and *l'*, such cut-out being effected by the series coil and through the series coil. In case the shunt should become open-circuited by some accident, the series coil will lift the armature and form the cut-out through the sleeves *l* and *l'*, the cut-out being established by and through the series coil. In the event of considerable resistance offered the current by the two electrodes when in cut-out,—the secondary cut-out having been effected by the armature and sleeves *l* and *l'*,—the sliding cores might in some one particular position fail to make good contact with the containing tubes. In such case,—the clutch rings having been lifted out of contact with the supporting ring,—it would leave the armature to effect the cut-out independent of any electrical contact, except such as it might have with the core containing tubes. An imperfect contact there might possibly produce heating or sparking; but I prevent such sparks and the damage which they might do, by establishing a permanent metallic contact through the metallic pellets within the tubes. The arc is inclosed in a globe which is air-tight at its top and provided with a yielding closure at its bottom so that, as the carbons burn, they consume the oxygen of the air without, however, allowing such oxygen to be renewed from the surrounding atmosphere. The yielding pan at the bottom of the globe will allow the expanding air and gases within the globe to escape, and little air, only, will leak through the bottom opening,—such as may be due to alternating expansion and contraction of the globe contents due to a varying circuit and consequent change of temperature. There can be no upward draft in the globe on account of the air-tight closure of the upper end of the same, and on account of the yielding fit of the pan against the lower opening of the globe. Therefore, as the oxygen of the air contained in the globe is consumed, such oxygen will be replaced by carbon-binoxide,—CO_2, which, in turn, will be reduced to—CO, carbon monoxide, which gas remains stable. In this manner the oxidation of the carbon is greatly retarded, effecting a considerable saving in the use of the carbons. As the yielding closure, however, has no packed bearing against the lower edge of the globe, but simply rests against said edge, atmospheric air may enter the arc-inclosing chamber and equalize the internal and external pressure, if the internal pressure becomes less than the external atmospheric pressure. Bursting of the globe by excessive rarefaction within the same, and consequent excessive external pressure, is thus avoided. The opening in the bottom of the arc-inclosing chamber forms a hand hole, through which the hand of the person trimming the lamp may be inserted into the arc-inclosing chamber, for the purpose of cleaning said chamber, removing burned-out carbons, repairing the exposed parts in the chamber, or inserting new carbons. Said bottom opening or hand hole is, therefore, of a sufficient size to admit of the free and unobstructed outlet of gases formed within the chamber, as said gases will bear against the the large surface of the yielding pan, and will escape sufficiently freely to prevent the possibility of explosion of the carbon-monoxide mingled with air, by ignition of said mixture from the arc of the lamp.

Other modes of applying the principle of my invention may be employed for the mode herein explained. Change may therefore be made as regards the mechanism thus disclosed, provided the principles of construction set forth respectively in the following claims are employed.

I therefore particularly point out and distinctly claim as my invention—

1. In an electric arc lamp, an arc-inclosing chamber closed air-tight at its top and sides, and closed,—but not air-tight,—at its bottom, to allow limited inlet to and free outlet from the chamber, substantially as set forth.

2. In an electric arc lamp, the combination of an arc-inclosing chamber, closed air-tight at all points excepting at the bottom, and a closure, which is not air-tight, for the opening at the bottom,—said closure having such fit as to allow limited inlet to and free outlet from the chamber, substantially as set forth.

3. In an electric arc lamp, the combination of an arc-inclosing chamber, closed air-tight at all points excepting at the bottom, and an outwardly yielding closure for the opening at the bottom,—said closure having such fit as to allow limited inlet to and free outlet from the chamber, substantially as set forth.

4. In an electric arc lamp, the combination of an arc-inclosing chamber, closed air-tight at its top and sides and formed with an opening at its bottom of sufficient size to form a hand hole for trimming and cleaning the lamp, and an outwardly yielding closure for such hand hole, substantially as set forth.

5. In an electric arc lamp, the combination of an arc-inclosing chamber, closed air-tight at its top and sides and formed with an opening at its bottom of sufficient size to form a hand hole for trimming and cleaning the lamp, and a pan supported outwardly yieldingly to close such hand hole and to have tight but not air-tight bearing against the edges of the same, substantially as set forth.

6. In an electric arc lamp, the combination of an arc-inclosing chamber closed air-tight at its top and sides, a carbon-holder supported from the upper portion of said arc-inclosing chamber and projecting toward the bottom of the same, and a pan secured outwardly-yielding upon said carbon-holder and closing the bottom of the arc-inclosing chamber, substantially as set forth.

7. In an electric arc lamp, the combination

of an arc-inclosing chamber closed air-tight at its top and sides, a carbon-supporting frame secured in said chamber, a carbon-holder secured in the lower end of the carbon-supporting frame, and a pan yieldingly supported upon said holder and closing the bottom of the arc-inclosing chamber, substantially as set forth.

8. In an electric arc lamp, the combination of an arc-inclosing chamber closed air-tight at its top and sides, a carbon-containing tube opening into the top of said chamber, a carbon-supporting frame secured in the arc-inclosing chamber, a carbon-holder secured in said carbon-supporting frame, and a pan yieldingly supported upon said holder and closing the bottom of the arc-inclosing chamber, substantially as set forth.

9. In an electric arc lamp, the combination of an arc-inclosing chamber closed air-tight at its top and sides, a carbon-containing tube opening into the top of said chamber, a carbon-supporting frame supported at its upper end in the top of the arc-inclosing chamber, a carbon-holder secured in the lower end of said carbon-supporting frame, and a pan yieldingly supported upon said holder and closing the bottom of the arc-inclosing chamber, substantially as set forth.

10. In an electric arc lamp, the combination of an arc-inclosing chamber closed air-tight at its top and sides, a carbon-containing tube extending into the top of said chamber, a carbon-supporting frame secured at its upper end in the top of the arc-inclosing chamber, a carbon-holder secured in the lower end of the carbon-supporting frame, and a pan yieldingly-supported upon said holder and closing the bottom of the arc-inclosing chamber, substantially as set forth.

11. In an electric arc lamp, the combination of an arc-inclosing chamber closed at its top and having an opening at its bottom, an upper carbon-container entering through the closed top of the chamber, and a frame in the chamber having an opening at the bottom-opening of the chamber, registering with the carbon-container, and of a diameter equal to the diameter of the greatest capacity of said container,—the opening in said frame being so located as to form the only passage for the insertion of carbons into the upper container, substantially as set forth.

12. In an electric arc lamp, the combination of an arc-inclosing chamber closed at its top and having an opening in its bottom, an upper carbon-container entering through the closed top of the chamber, a carbon-supporting frame within the chamber and having an opening at the bottom opening of the chamber, registering with the upper carbon-container and of a diameter equal to the diameter of the greatest capacity of said upper container, and a lower carbon-holder secured in said opening,—said opening in the carbon-supporting frame being so located as to form the only passage for the insertion of carbons into the upper container, substantially as set forth.

13. In an electric arc lamp, the combination of an arc-inclosing chamber closed at its top and having an opening in its bottom, a carbon-containing tube extending into the closed top of said chamber, a carbon-supporting frame secured in the arc-inclosing chamber and having an opening at its lower end and at the bottom-opening of the chamber, registering with the carbon-containing tube and of a diameter equal to the greatest diameter of the carbon capable of being held in said tube, and a carbon-holder secured in said opening in the frame,—said opening in the carbon-supporting frame being so located as to form the only passage for the insertion of carbons into the upper container, substantially as set forth.

14. In an electric arc lamp, the combination of a carbon-supporting frame forming one series terminal, a metallic lower carbon-holder removably secured in said frame and in contact with the same, and an insulating handle in the lower end of said carbon-holder, substantially as set forth.

15. In an electric arc lamp, the combination of an arc-inclosing chamber formed with a hand hole at its bottom, a lower carbon-holder forming one series terminal, and a closure for the hand hole yieldingly supported by and insulated from the carbon-holder, substantially as set forth.

16. In an electric arc lamp, the combination of an arc-inclosing chamber, a lower carbon-holder forming a series terminal, an insulated handle secured in the lower end of said carbon-holder, a pan yieldingly supported upon said handle and covering the bottom opening of the arc-inclosing chamber, and a washer upon the handle and at the lower end of the carbon-holder,—said washer serving as an upper stop for said pan, substantially as set forth.

17. In an electric arc lamp, the combination of an arc-inclosing chamber, a carbon-supporting frame secured in said chamber and formed with an opening in its lower end having a screwthreaded portion and an upper tapering portion, a carbon-holder having a screwthreaded portion and a slitted portion and fitting in said opening, and a pan yieldingly-supported upon said carbon-holder, and covering the open bottom of the arc-inclosing chamber, substantially as set forth.

18. In an electric arc lamp, the combination of an arc-inclosing chamber having an opening at its bottom, a carbon-holder at the bottom of said chamber provided with a handle, a spring upon said handle, and a pan fitted to slide upon the handle and cushioned by said spring, said pan fitting to close the opening in the arc-inclosing chamber, substantially as set forth.

19. In an electric arc lamp, the combination of an arc-inclosing chamber having an opening at its bottom, a carbon-supporting frame

supported within said chamber and having an opening at its lower end formed with a screwthreaded portion and an upwardly tapering upper portion, a carbon-holder consisting of a screwthreaded sleeve fitting in the threaded portion of said opening and a slitted tube having its slitted end entering the tapering portion of the opening, and provided with an insulated handle, a spring upon said handle and confined upon the same at its lower end, a sleeve over said spring and formed with a flange bearing against the upper end of the same, and a pan fitted to slide upon the handle to bear against the flange and closing the opening in the bottom of the arc-inclosing chamber, substantially as set forth.

20. In an electric arc lamp, the combination of an electrode-containing tube, sets of radial brushes supported, one above the other upon said tube, a set of radial clutches supported upon the tube, and the armature of the electro-magnet in the lamp constructed to actuate said clutches, substantially as set forth.

21. In an electric arc lamp, the combination of clutches suspended to have longitudinal and radial movement in relation to the electrode, and brushes suspended at a distance below said clutches to swing radially and to engage the electrode by their gravity,—said brushes thereby feeding the current to the electrode and completely centering and guiding the same, substantially as set forth.

22. In an electric arc lamp, the combination of an electrode-containing tube, clutches radially suspended in said tube to engage the electrode from radiating directions, and current feeding and centering brushes suspended in the lower end of the tube gravitating toward the axis of the same,—said brushes thereby feeding the current to the electrode and centering the same at its lowermost point of support, substantially as set forth.

23. In an electric arc lamp, the combination of two sets of radial brushes, arranged one above the other to support the electrode, a set of radial clutches arranged above said brushes, and the armature of the electro-magnet in the lamp, constructed to actuate said clutches, substantially as set forth.

24. In an electric arc lamp, the combination of an electrode-containing tube, an electro-magnet having a movable armature, and a plurality of sets of rings pivoted to project into the interior of the tube, one of said sets capable of being engaged by the armature and to be forced toward and from the axis of the tube by the movement of the armature, substantially as set forth.

25. In an electric arc lamp, radially arranged brushes suspended at points above their centers of gravity to swing inward and engage the electrode by their gravity, substantially as set forth.

26. In an electric arc lamp, radially arranged brushes suspended to have longitudinal and radial play relatively to the electrode, and to engage the same by their gravity substantially as set forth.

27. In an electric arc lamp, the combination of an electrode-containing tube, and brushes suspended to have longitudinal and radial play through the sides of said tube and to engage the electrode within the latter by their gravity, substantially as set forth.

28. In an electric arc lamp, the combination of clutches radially suspended around the electrode, and a separate movable armature of the electro-magnet in the lamp,—said armature constructed to engage and actuate the clutches when attracted, substantially as set forth.

29. In an electric arc lamp, the combination of an electrode-containing tube formed with longitudinal slots, and rings pivotally supported in said slots, to engage the electrode, substantially as set forth.

30. In an electric arc lamp, the combination of clutches suspended radially in their relation to the electrode, and a separate movable armature of the electro-magnet in the lamp,—said armature having surfaces which engage and actuate the clutches when the armature is attracted, substantially as set forth.

31. In an electric arc lamp, the combination of radially arranged clutches suspended to have longitudinal and radial movement in their relation to the electrode, and a separate movable armature of the electro-magnet in the lamp,—said armature having surfaces adapted to engage and force inwardly said clutches, substantially as set forth.

32. In an electric arc lamp, the combination of radially arranged and pivotally supported clutch rings, an electro-magnet, and a movable armature for the same formed with beveled surfaces engaging said rings when the armature is raised, substantially as set forth.

33. In an electric arc lamp, the combination of clutches suspended to have longitudinal and radial play in their relation to the electrode, and a separate movable armature of the electro-magnet in the lamp,—said armature having beveled surfaces engaging said clutches, substantially as set forth.

34. In an electric arc lamp, the combination of an electrode-containing tube, clutches suspended to have longitudinal and radial play through the sides of said tube, and a separate movable armature of the electro-magnet in the lamp,—said armature having beveled surfaces engaging said clutches, substantially as set forth.

35. In an electric arc lamp, the combination of radially arranged clutches, and a movable armature of the electro-magnet in the lamp, constructed to successively engage pairs of opposite clutches when attracted by the magnet, substantially as set forth.

36. In an electric arc lamp, the combination of radially arranged clutches having longitudinal and radial play relatively to the electrode, and a movable armature having opposite surfaces of different incline from

other opposite surfaces,—said differently inclined surfaces successively actuating opposite clutches when the armature is attracted, substantially as set forth.

37. In an electric arc lamp, the combination of clutches having radial and longitudinal play relative to the electrode and arranged in pairs of opposite clutches, and an armature of the electro-magnet in the lamp formed with pairs of opposite inclined surfaces having different inclines to successively actuate the pairs of opposite clutches, substantially as set forth.

38. In an electric arc lamp, the combination of clutch rings arranged in pairs of opposite rings to have radial and longitudinal play relative to the electrode, and a movable armature of the electro-magnet in the lamp, constructed with beveled surfaces arranged in opposite pairs to engage said rings, each pair of opposite surfaces having a different incline so as to successively actuate the pairs of clutch rings, substantially as set forth.

39. In an electric arc lamp, the combination of a longitudinally slotted electrode-containing tube, rings pivotally supported to project through the slots of the tube and into the same, and a movable armature of the electro-magnet in the lamp, said armature having upwardly beveled surfaces engaging said rings, substantially as set forth.

40. In an electric arc lamp, the combination of the series terminals, and current feeding brushes suspended from one of said terminals to engage the electrode by gravity and to swing down into contact with the other terminal when the electrode is removed, substantially as set forth.

41. In an electric arc lamp, the combination of one series terminal, current feeding brushes supported from said terminal to have radial and longitudinal movement relative to the electrode and to be moved upward and outward by the insertion of said electrode, and the other series terminal having a projection engaged by the brushes when the electrode is removed, substantially as set forth.

42. In an electric arc lamp, the combination of a series terminal having an electrode-container, the other series terminal having a projection, and brushes supported in said electrode-container to have longitudinal and radial play relative to said container and to have contact with the projection when the electrode is removed, and to be brought out of such contact when the electrode is inserted, substantially as set forth.

43. In an electric arc lamp, the combination of one series terminal having a tubular electrode-container, the other series terminal formed with a projecting portion, and brushes supported in said former terminal to have longitudinal and radial play in their relation to said electrode-container and adapted to have contact with said projection when the electrode is removed from its engagement with the brushes and to be brought out of such contact when the electrode is inserted, substantially as set forth.

44. In an electric arc lamp, the combination of an electrode-containing tube forming one terminal of the series, radial brushes supported to have longitudinal and radial play through the sides of said tube, and a disk through which the electrode-containing tube passes, said disk forming a part of the other terminal of the series and being formed with an annular flange adapted to have contact with said brushes when the electrode is removed, and to have such contact interrupted when the electrode is inserted, substantially as set forth.

45. In an electric arc lamp, the combination of one terminal of the series, the movable armature of the electrode-feeding mechanism, said armature forming a part of said terminal, and a contact forming a part of the other terminal of the series and arranged to have contact with the armature when the latter is at the extreme of its attracted position, substantially as set forth.

46. In an electric arc lamp, the combination of one terminal of the series, clutches for the electrode movably supported in said terminal and in contact with the same, a movable armature engaging said clutches when attracted, and a contact forming a part of the other terminal of the series and arranged to have contact with the armature when the latter is at the extreme of its attracted position, substantially as set forth.

47. In an electric arc lamp, the combination of an electrode-containing tube forming one terminal of the series, clutches supported in said tube to have longitudinal and radial play in the same, a contact forming a part of the other terminal of the series, and a movable armature having inclined surfaces engaging the clutches when attracted and forming a cut-out contact with the terminal contact when at the extreme of its attracted position, substantially as set forth

48. In an electric arc lamp, the combination of a disk forming a part of one terminal of the series, an electrode-containing tube secured in electrical contact with said disk through the center of the same, clutches movably supported upon said tube to have longitudinal and radial play through the sides of the same and in electrical contact with the same, a movable armature having inclined surfaces engaging and having contact with said brushes when attracted, and contacts inserted through but insulated from the disk, forming parts of the other terminal of the series, and having electrical cut-out contact with the armature when the latter is at the extreme of its attracted position, substantially as set forth.

49. Two or more magnets arranged with all of their poles in a complete magnetic series and with gaps between all of their opposite

poles, in combination with an armature movable within such gaps to complete the magnetic circuit, substantially as set forth.

50. Two or more electro-magnets arranged with all of their poles in a complete magnetic series and with gaps between all of their opposite poles, in combination with an armature movable within such gaps to complete the magnetic circuit, substantially as set forth.

51. In an electric arc lamp, the combination of an electro-magnet of the horseshoe type formed with axial bores in its limbs, another electro-magnet of the horseshoe type arranged with both of its poles at a distance from the poles of said first magnet and in magnetic series with the latter, and formed with bores registering with the bores in the limbs of the first magnet, and a movable armature having cores sliding within the bores of said magnets and in the joint fields of the same, substantially as set forth.

52. In an electric arc lamp, the combination of an electro-magnet of the horseshoe type having axial bores in its limbs, another electro-magnet of the horseshoe type arranged with both of its poles at a distance from the poles of the first magnet and in magnetic series with the latter, and formed with axial bores in its limbs, brass tubes secured within said bores to space apart the poles of the magnet, and a movable armature having its cores sliding within said tubes and in the joint fields of said magnets, substantially as set forth.

53. In an electric arc lamp, the combination of an electro-magnet of the horseshoe type formed with axial bores in its limbs, another electro-magnet arranged with both of its poles at a distance from the poles of the first magnet and in magnetic series with the latter, brass tubes secured within said axial bores to space apart the poles of the magnet, and a movable armature having cores sliding within said tubes in the joint fields of said magnets, substantially as set forth.

54. In an electric arc lamp, an electro-magnet having axial bores in its limbs, another electro-magnet having registering bores and arranged with its poles at a distance from the poles of said magnet and in magnetic series with the same, and lining tubes within the bores and the armature,—said magnets and tubes forming a portion of a series terminal, in combination with a movable armature having its cores sliding within the lining tubes and in the fields of said magnets and forming a movable part of a series cut-out, and metallic pellets within the lining tubes and in electrical contact with the armature cores and said tubes, substantially as set forth.

55. In an electric arc lamp, the combination of an airtight casing, an electro-magnet having a disk forming the top of said casing and having bores through said disk and through its limbs, an electro-magnet having axial bores through its limbs registering with the bores of said first electro-magnet, metal tubes fitted in said bores and having their upper ends closed air tight, and an armature in the casing having its cores sliding in said tubes, substantially as set forth.

56. In an electric arc lamp, the combination of an arc-inclosing chamber closed air-tight at its sides and top, a tube fitted in the top of said chamber and closed air-tight at its upper end, said tube serving as an electrode-containing tube, clutch mechanism and current-feeding mechanism for the electrode engaging the same through slots in said tube, and an airtight chamber inclosing the slotted portion of the tube, substantially as set forth.

57. In an electric arc lamp, the combination of a central electrode-containing tube, an arc-inclosing chamber supported from the lower portion of said tube, an electro-magnet upon the tube above said chamber, and electrode and current feeding mechanism supported by said tube, between the electro-magnet and the arc-inclosing chamber, substantially as set forth.

58. In an electric arc lamp, a carbon-holding tube formed with a contracted socket portion having longitudinal slits closed at both ends, substantially as set forth.

59. In an electric arc lamp, a carbon-holding tube formed with a contracted and longitudinally slitted socket portion and with an internal bead stop above said socket portion, substantially as set forth.

60. In an electric arc lamp, the combination of a central carbon-containing tube, an electro-magnet supported upon said tube, a negative terminal disk supported upon the tube, and a nut upon the lower end of said tube securing said disk upon the tube, substantially as set forth.

61. In an electric arc lamp, the combination of a central carbon-containing tube, an electro-magnet secured upon said tube and having a disk, a negative terminal disk upon the tube, a casing between the magnet disk and terminal disk, and a nut upon the lower end of the tube securing the disk and clamping it against the casing, substantially as set forth.

62. In an electric arc lamp, the combination of a central carbon-containing tube, an electro-magnet secured upon said tube, clutches supported upon said tube, an armature sliding around said tube and actuating said clutches, brushes supported upon said tube, a negative terminal disk supported upon said tube, a nut upon the tube and securing said disk, a lower carbon-supporting frame supported upon said tube, and a globe clamped between said frame and terminal disk, substantially as set forth.

63. In an electric arc lamp, the combination of an arc-inclosing chamber, an airtight casing communicating with said arc-inclosing chamber, an electro-magnet outside of said casing and having airtight bores communicating with said airtight casing, and an armature in said airtight casing and having cores

movable in said bores, substantially as set forth.

64. In an electric arc lamp, sets of brushes suspended to have radial play in their relation to the electrode and to engage the same by their gravity, said sets of brushes being arranged, one set above the other, and at a distance one from the other, substantially as set forth.

65. In an electric arc lamp, the combination of the armature of the electro-magnet of the lamp, a set of clutches suspended to be engaged and actuated by the armature, to have radial play in their relation to the electrode, and to bear against the same by gravity when disengaged from the armature, and sets of brushes suspended to have radial play in their relation to the electrode and to engage the same by gravity,—said sets of clutches and brushes being arranged at distances above one another to engage and center the electrode at a plurality of points, substantially as set forth.

66. In an electric arc lamp, the combination of a feeding coil, an armature for the same forming a series terminal, and a contact forming another series terminal and in the path of said armature when the latter is attracted, substantially as set forth.

In testimony that I claim the foregoing to be my invention I have hereunto set my hand this 19th day of October, A. D. 1892.

WILLIAM JANDUS.

Witnesses:

WM. SECHER,

J. C. TURNER.