

J. B. FULLER.  
Electric Lamps.

No. 218,375.

Patented Aug 12, 1879.

FIG. 1.

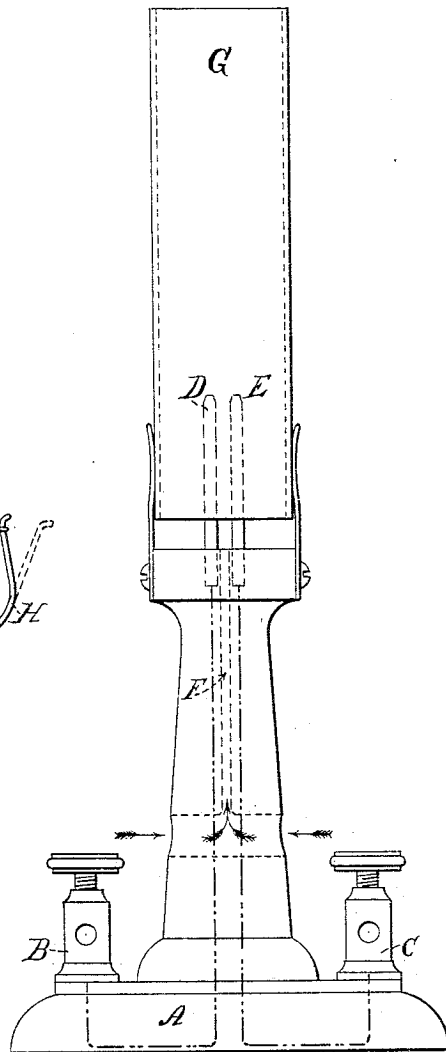


FIG. 2.

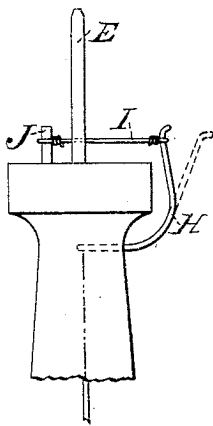
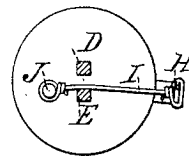


FIG. 3.



WITNESSES:

*James J. Woods*  
*Maurice B. Hull*

INVENTOR.

*Sam Billings Fuller*

# UNITED STATES PATENT OFFICE.

JIM BILLINGS FULLER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENT, TO THE FULLER ELECTRICAL COMPANY, OF NEW YORK.

## IMPROVEMENT IN ELECTRIC LAMPS.

Specification forming part of Letters Patent No. **218,375**, dated August 12, 1879; application filed January 30, 1878.

*To all whom it may concern:*

Be it known that I, JIM BILLINGS FULLER, of the city of New York, State of New York, have invented a new and useful Improvement in Electric Lamps, of which the following is a specification.

This improvement relates to electric lamps having carbons parallel to each other; and consists, first, in the employment of a current of air so directed as to flow around or between said carbons and toward their luminous points, for the purpose of preventing the electric flame from burning along the surface of the carbons, where there is the least electrical resistance, and of keeping the flame at the points of the carbons; second, in the peculiar means employed for extinguishing the light automatically, consisting in connections so arranged as to be burned off, and the electric circuit with the lamp opened, and the electric current interrupted by the action of the flame.

There are many ways in which a current of air may be applied in carrying out this invention, depending on the construction of the lamp and the position of the carbons.

I consider the manner herein described the most practicable when the carbons are placed in a vertical position, with the points upward.

Figure 1 is a side view of the lamp. Figs. 2 and 3 are a side view and section of the device for automatically extinguishing the light.

In the drawings, A represents the base of an electric lamp. The electric current from the generator is conducted to the binding-posts B and C, and thence to the carbons D and E. These carbons are separated a short distance apart, and the electric current flows through the electric arc formed between the points of said carbons.

F is a tube arranged so as to give direction to a current of air around or between the carbons toward their luminous points.

A chimney, G, is arranged around said carbons, so as to produce a draft of air from the heat of the electric flame.

When the carbons are used with their points downward, or in any position different from that above described, the air may be forced through the tube F by any convenient

means; or any substitute for the tube may be used which will give the current of air the necessary direction, as aforesaid.

H is a spring, and I is a wire or metallic strip, both of which are in circuit with one of the carbons, the wire being arranged so as to be burned off by the flame at the desired point, thereby breaking the circuit and extinguishing the light.

There are many ways in which the circuit may be broken by burning off a connection. A cord may pass between or around the carbons, holding the connecting mechanism in closed circuit until the burning off of said cord by the electric flame opens the circuit and interrupts the current. Therefore I do not confine myself to any particular mechanism for this purpose, provided the current is interrupted by the means described.

I am aware that glass globes have been placed around the carbons of electric lamps for the purpose of softening the light and protecting it from the wind and storm.

I claim—

1. An electric lamp in which the electric arc or flame is maintained at the points of the carbons, placed parallel with one another and vertical, or nearly so, by means of a current of air so directed and confined as to flow around or between said carbons toward their luminous points, substantially as and for the purpose specified.

2. In an electric lamp, the combination, with the carbons, placed parallel with one another and in a vertical position, or nearly so, of a chimney arranged around the carbons, so that the heat from the electric flame shall cause a current of air to flow around or between said carbons, substantially as and for the purpose set forth.

3. An electric lamp in which the connections are arranged so as to be burned off by the action of the electric flame, thereby breaking the electric circuit within the lamp and extinguishing the light, substantially as described.

JIM BILLINGS FULLER.

Witnesses:

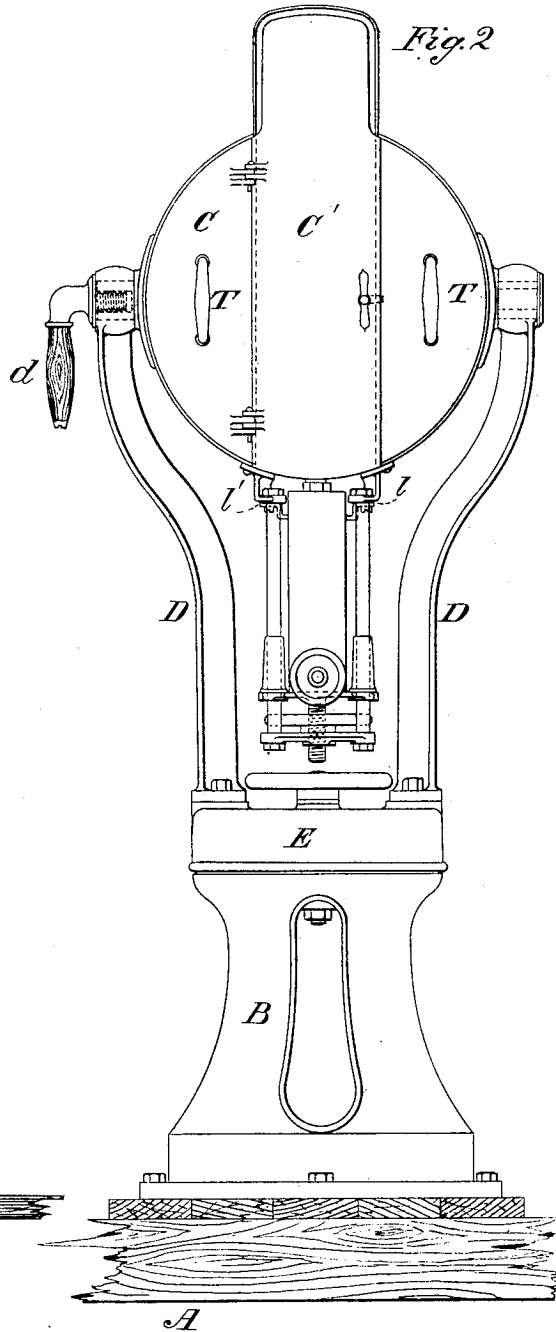
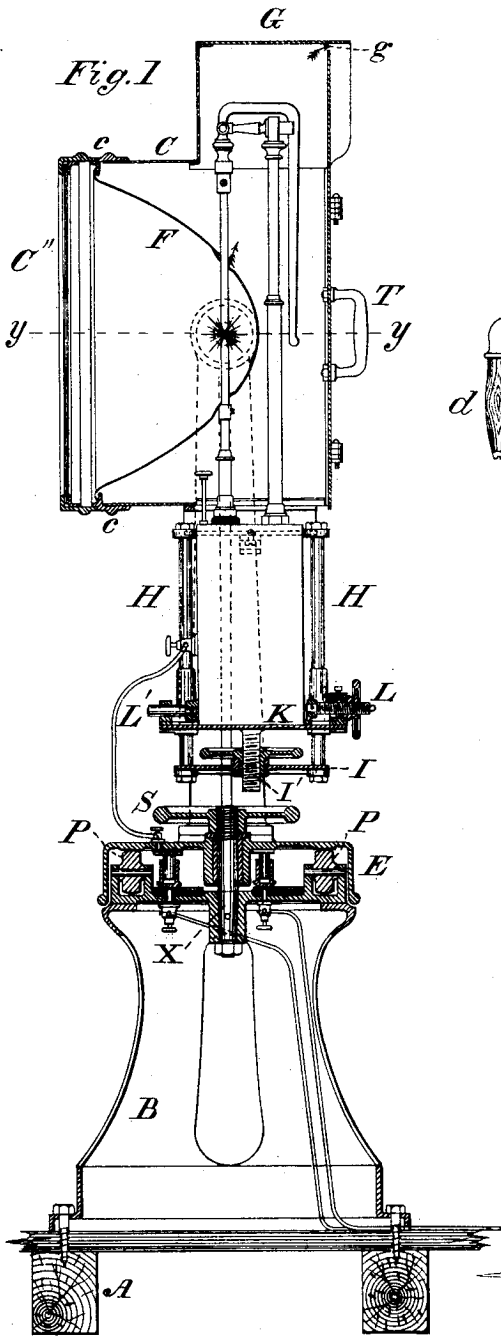
JAMES J. WOOD,  
MAURICE B. HULL.

J. R. F. KELLY.

ADJUSTABLE REFLECTOR FOR ELECTRIC LAMPS.

No. 255,514.

Patented Mar. 28, 1882.



Witnesses:

*Leopold & Curtis  
Humphreys*

Inventor.

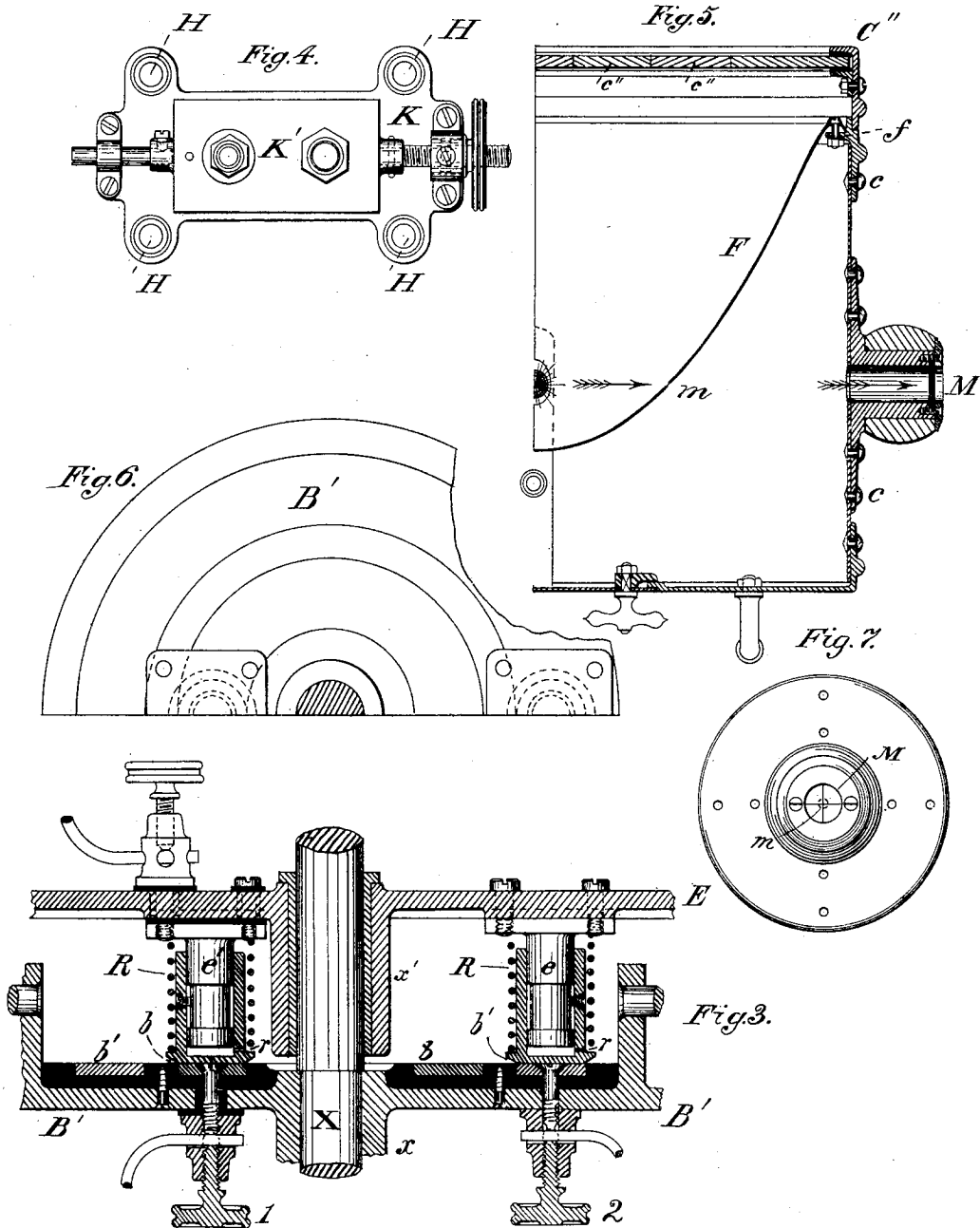
*James R. Kelly.  
per Parker W. Page.  
Attorney*

J. R. F. KELLY.

ADJUSTABLE REFLECTOR FOR ELECTRIC LAMPS.

No. 255,514.

Patented Mar. 28, 1882.



Witnesses:  
*Richard C. Curtis*  
*Hampshire*

Inventor:  
*James R. Kelly*  
*per Parker W. Page*  
 Attorney

# UNITED STATES PATENT OFFICE.

JAMES R. F. KELLY, OF BROOKLYN, ASSIGNOR TO THE UNITED STATES  
ELECTRIC LIGHTING COMPANY, OF NEW YORK, N. Y.

## ADJUSTABLE REFLECTOR FOR ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 255,514, dated March 28, 1882.

Application filed March 5, 1881. (No model.)

To all whom it may concern:

Be it known that I, JAMES R. F. KELLY, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Adjustable Reflectors for Electric Lamps, of which the following is a specification, reference being had to the drawings accompanying and forming a part thereof.

My invention relates to devices for concentrating, reflecting, and directing the rays of light from a powerful illuminating source, such as the voltaic arc; and its object is to produce an efficient and practicable apparatus for this purpose capable of being employed in all cases where an intense and penetrating light is necessary, such as an inspection by night of an enemy's works, in navigating narrow or dangerous streams, detecting the movements of vessels, or in preventing collisions at sea. To this end I have constructed the improved apparatus hereinafter set forth and claimed, for use with an electric lamp, and will now proceed to describe the same by reference to the drawings, in which—

Figure 1 is a vertical sectional view, and Fig. 2 a rear view in elevation, of the complete apparatus; Fig. 3, a development of a portion of Fig. 1, illustrating the means of completing the electric circuit to the device; Fig. 4, a plan view of the plate and screws for adjusting laterally the position of the lamp; Fig. 5, a horizontal section of one half of the reflector and its case, taken through line *y y* in Fig. 1; and Fig. 6 is a plan view of a portion of the upper side of the stationary plate that supports the lamp and reflecting devices. Fig. 7 is a front view of the hollow trunnion and index-plates.

B is a hollow cast-iron base, clamped by bolts to a stationary support or to the deck of a vessel, represented by A.

C is a case of sheet metal for containing the reflector and lamp, supported on trunnions pivoting on the standards D D, which are rigidly secured to a revolving cap, E. The case C is composed of a sheet-metal body strengthened by bands of thicker metal, *c*, corrugated or beaded, and riveted thereto, as shown in Figs. 1 and 5. The band encircling the outer or front rim of the case is cast with a shoulder or flange, *f*, on its inner surface, to which the flaring rim of a parabolic reflector, F, is secured, fastened by clamps or screws. The case C has an enlargement, G, on top to make room

for the lamp, and an opening in the rear closed by a hinged door, C'. That part of the door which closes the enlargement G is made slightly smaller than the rest, so that an air-space, *g*, remains when the door is shut, through which pass the heated air and gas from around the electric arc, as indicated by the arrows. Were no such means of escape afforded to the heated air, it would, by being confined in the case about the reflector, increase the temperature and do injury by warping or discoloring the metal. By the above arrangement, however, a free circulation of cool air is maintained.

Handles T T are secured to the case C, preferably to the back, for adjusting it in any desired position, and a clamping-screw, *d*, is employed for fixing the case at any angle to which it may have been directed.

The open front of the reflector and case is closed by a cap, C'', composed of a metal rim or bezel, with a glass disk or plate. The circular glass plates commonly used for this purpose have a tendency, when exposed to varying temperatures, to expand and contract unequally, thus destroying the parallelism of the rays reflected through them and reducing the efficiency of the light. I have lessened this tendency to a marked degree by constructing the glass front of the cap C'' of a number of independent strips, *c''*, with smoothly-fitting edges, as shown in Fig. 5.

From the under side of the case C depends a frame consisting of four bars, H H, supporting a rectangular platform, I. This platform serves as a support for adjusting-screw mechanism for raising and lowering a plate or block, K, provided with projections or hubs, through which pass the rods H, serving as guide-bars.

In addition to the plate or block K, I employ another plate, K', made laterally adjustable on the same by means of a screw-shaft, L, and guides, L'. On this plate rests the lamp, which is, by preference, a focusing-lamp, such as is shown in Patent No. 208,253, September 24, 1878.

It will be seen that the length of the lateral adjusting-screw is such that the arc may be carried considerably beyond the center of the focus, thereby creating a widely-diverging beam where it is desired to illuminate surrounding objects within short range.

To prevent jarring or displacement of the lamp, additional guides (which in this instance

are extensions of the rod supporting hangers *ll*) are provided, which bear against the smooth sides of the upright part *K'* and prevent any accidental displacement thereof. The parts *K K'* thus constitute, in effect, a carrier for the carbon-holders which is both vertically and laterally adjustable.

The carbon-holders of the lamp pass up through an aperture made therefor in the metal case *C*. The carbons are fitted to these sockets and their points are brought in contact inside the reflector by inserting them through suitable holes therein.

It is obviously essential that for the best effects the center of light should be exactly in the focus of the reflector, and an absolutely accurate focusing-lamp being practically impossible, owing to inequalities of structure in the carbon pencils, it becomes necessary to occasionally adjust the position of the arc.

This is effected by the vertical adjusting-screw *I'* and the horizontal adjusting-screw *L*.

To ascertain when the light is in the proper position, I make use of the following means:

On one side of the case the trunnion is made hollow and its outer end, *M*, closed by a ground-glass plate held in position by a cap or ring. A small pin-hole, *m*, in the reflector *F* projects an inverted image of the arc on the ground glass, on which are marked cross-lines in such a position that the projected image will appear at the intersection only when the arc is in the exact focus of the reflector. By this means the adjustments are readily and accurately obtained without exposing the eyes to the direct glare of the light.

The means employed for turning the reflector in a horizontal plane are as follows: On the supporting-base *B* is suitably secured a disk, *B'*, provided near its rim with four or more friction-rollers, *P*, either rolling loosely or journaled in raised flanges thereon. Through the center of the disk *B'* passes a shaft, *X*, forming part of a clamping device for holding in place cap *E*, which carries the supporting-standards *DD* and fits down over the disk *B'* and rollers *P*. Shaft *X* is secured to the disk *B'* by a pin, which prevents it from turning in the hub *x*. It passes through cap *E* in a sleeve in the hub *x'*, which allows the cap to be freely rotated around it on the rollers until it is clamped down by tightening the screw *S*.

In order that the conductors, which carry the current to the lamp in the reflector, may be protected from abrasion and injurious effects of the weather by passing up through the base *B*, and at the same time not prevent the turning of the reflector in either direction, I lead them to two binding-posts, 1 and 2, attached to the under side of disk *B'* in the interior of the hollow base. The binding-posts are connected respectively with two concentric metal rings, *b b'*, embedded in an insulating material, and having flat smooth bearing-surfaces, on which metal cups *R*, held in place by stationary teats *e e'*, depending from the

under side of cap *E*, are held in contact by means of spiral springs surrounding them, as shown. The teat *e'* connects with an insulated binding-post on cap *E*, from which the current is carried by means of a wire to one of the carbons of the electric lamp. The circuit from *e* is completed to the outer carbon either by means of a wire connection or through the metal frame of the reflector-stand and lamp.

To insure a good electrical contact between the teats *e e'* and their inclosing-cups, it is necessary to have them fit so tightly together that they prevent the escape of the confined air when they are forced together. To obviate this, small air-holes *r* are made through the cups *R* to allow a free play of one within the other, and thereby maintain a constant and even pressure of the cups on the contact-strips *b b'* when the reflector is revolved.

The apparatus is manipulated and the light thrown in any desired direction, as has been hereinbefore stated, by a person taking hold by the handles *TT* and moving the reflector in either a vertical or horizontal plane. The device above described forms a durable and convenient instrument, and is capable of a wide range of usefulness.

I am aware that devices for this purpose are not broadly new, and that reflectors have been constructed hitherto which were capable within certain limits of projecting the light in the desired direction. Such, therefore, I do not claim broadly.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The case *C*, having an extension, *G*, for containing the upper portion of an electric-lamp frame, open at the back and provided with a door which leaves, when closed, a space, *g*, for the escape of the heated air from within the case.

2. The combination of a sheet-metal case, *C*, and a strengthening-band, *c*, having an internal flange, *f*, to which is attached the rim of a parabolic reflector, *F*, as shown.

3. The hollow trunnion *M*, having a translucent indexed plate, in combination with a pin-hole, *m*, in the reflector *F* for adjusting the position of the arc, substantially in the manner described.

4. The combination, with case *C*, of an electric lamp and a frame for supporting the same, provided with stationary base and vertically-adjustable plate for raising and lowering the lamp, as and for the purpose set forth.

5. The combination, with the stationary base and vertically-adjustable plate of the lamp-supporting frame *H*, of the plate *K'* and horizontal adjusting mechanism *L L'*, substantially as described.

In testimony whereof I have hereunto set my hand this 2d day of March, 1881.

JAMES R. F. KELLY.

Witnesses:

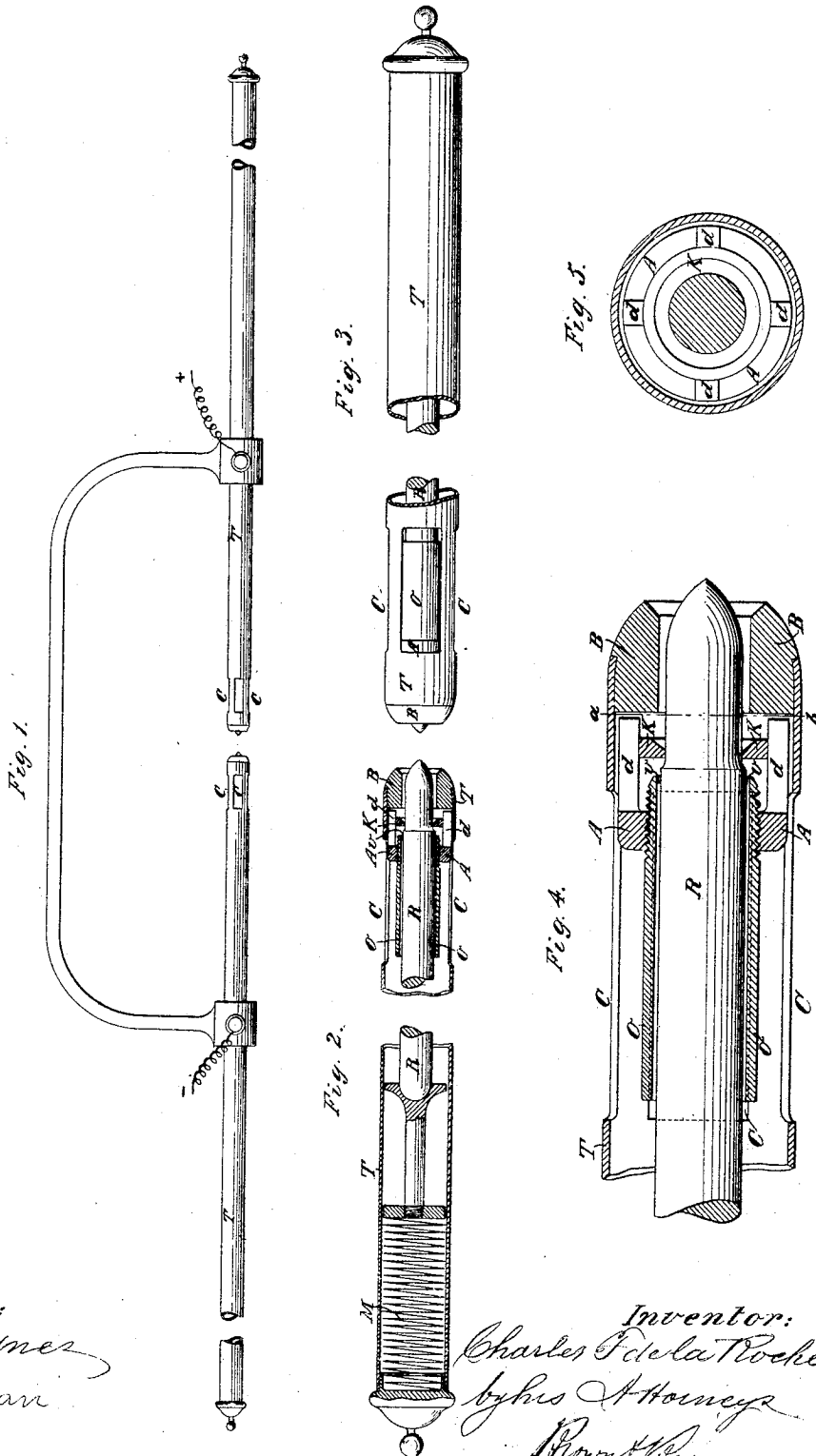
W. H. HARTLEY,  
E. G. HEBBERD.

(No Model.)

C. F. DE LA ROCHE.  
VOLTAIC ARC ELECTRIC LAMP.

No. 264,257.

Patented Sept. 12, 1882.



Witnesses:  
*Frederick Haynes*  
*Edw. L. Moran*

Inventor:  
*Charles F. de la Roche*  
by his Attorneys  
*Blount Brown*

# UNITED STATES PATENT OFFICE.

CHARLES FERDINAND DE LA ROCHE, OF PARIS, FRANCE.

## VOLTAIC-ARC ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 264,257, dated September 12, 1882.

Application filed July 7, 1882. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES FERDINAND DE LA ROCHE, of Paris, France, have invented a new and useful Improvement in Voltaic-Arc Electric Lamps, of which the following is a specification, reference being had to the accompanying drawings.

The object of my invention is to enable the feeding or advancement of the carbons to be effected by the direct action of a spring or counter-weight, which presses them against a stop without the aid of clock-work or other complicated mechanism.

The invention consists principally in the combination, with a guide-tube through which the electrode passes, of an abutment-ring which is attached to the said tube, and between which and the front end of said tube there is provided an open space, the portion of the electrode within the said tube being protected from the surrounding air, but the heated portion exposed in the open space between the said tube and the said ring being exposed to the air, so as to permit of its disintegration to the degree or extent desired to permit it to be fed forward to the abutment-ring.

The invention also consists in making the said ring adjustable relatively to the said tube for the purpose of varying the open space between them to regulate the feeding forward or advance of the electrodes.

The invention further consists in the method of attaching the abutment-ring to the said tube, whereby provision is afforded for the adjustment of the said ring to vary the open space between them and regulate the feeding of the electrode.

There have been previously used for the regulation of the advance or feed of the electrodes abutment rings or stops, against which the electrodes have been pressed by weights or springs; but such regulation has not been successful, sometimes owing to the voltaic arc consuming not only the part of the electrode protruding in advance of such ring, but also a sufficient length behind the said ring to produce frequent irregularities in the advancement of the electrode under the action of the spring or weight which presses it forward, and in other cases, owing to the electrode not being con-

sumed fast enough, it has melted the ring, and so destroyed the regulation.

I have recognized that the combustion and using up of the electrodes stop where they cease to be exposed to the combined action of the heat disengaged by the arc and of the destructive action of the air. Thus, for example, if we take two electrodes, one free from any envelope or outer protection from air advancing toward the other, which is surrounded with a tube to or nearly to its extremity, the combustion of the latter will be considerably less than that of the former. I have also recognized that the consumption stops at the end of the tube in a well-defined line, and that the part surrounded by the tube is not impaired in hardness. The action of the air, then, plays an important part in the consumption of the electrodes. My system permits, then, the practical utilization of the abutment of the electrodes against a ring to regulate their advance by the action of a spring or other means of propulsion, and by it a saving of about fifty per cent. in the consumption of the carbon of the electrodes.

Figure 1 in the drawings is a side view of a lamp with my invention applied. Fig. 2 is a central longitudinal section of one of the electrode-holders and its feeding apparatus on a larger scale than Fig. 1. Fig. 3 is an outside longitudinal view corresponding with Fig. 2. Fig. 4 is a central longitudinal section of a portion of the holder on a still larger scale. Fig. 5 is a transverse section on the line *a b* of Fig. 4.

O is a tube, of copper, platinum, or other metal, of such size that the electrode may pass freely through it, and having screwed onto its front portion a collar, A, furnished with prongs *d d*, which receive between them and support and hold the abutment ring or washer K, the interior of which is of a diameter a little less than that of the electrodes employed, in order that the latter may be only allowed to be advanced or fed according to their consumption by the impulse of the spiral spring M, which is placed in the outer tube, T, which contains the electrode and its feeding and controlling apparatus. Between the extremity of the tube O and the ring K, I leave a space, *v*, the width of which may be regulated according to the



diameter of the electrodes by screwing the collar A farther or not so far on the tube O. According as the portion of the electrode within the space  $v$  is attacked by the heat, it is disintegrated, and the spiral spring M advances the electrode R in proportion to its consumption. Under these conditions the heat transforms my system into a pyrometric apparatus, of which the separation or space  $v$  becomes either greater or less, according as the voltaic arc consumes the electrodes more or less rapidly and brings them more or less rapidly to the ring K; but in either case the electrode cannot advance at once a distance greater than the width of the space  $v$  determined beforehand.

In order to prevent the heat and the oxidation from causing any change of thickness of the ring K and of the tube O, I prefer to construct of platinum both the ring K and also the extremity of the tube O, which limits the space  $v$ . Moreover, in order to protect this metallic part of my system, I fit the front end of the tube T with a ring, B, of magnesia or other refractory substance.

In order to permit the exterior arc to corrode the electrode in rear of the abutment-ring K, and to keep the protecting-tube O cool, I provide in the outer tube, T, openings C C, opposite to the said tube O. It is for the same purpose that the collar A is slotted, so that its front part consists only of three or four prongs,  $d d$ , which support the abutment-ring K, and I also make the ring B of magnesia, with a central opening of a diameter larger than the electrode, in order to provide free access between them to the surrounding air.

In the example of the lamp represented in the drawings the two electrodes are pressed forward by two spiral springs, M M, placed in the tubes T; but it may be understood that a single spring may be used applied directly to one electrode, the other electrode being put in movement by means of levers, racks, or pinions, which will be also operated by the same spring.

This invention may be applied to all kinds of voltaic-arc electric lamps, whether the electrodes be horizontal, vertical, or inclined, oblique, or parallel.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, in an electric lamp, of a guide-tube for the electrode and an abutment-ring attached to the said tube, and between which and the end of the said ring there is a determined open space provided, substantially as and for the purpose herein described.

2. The combination of the guide-tube O and the adjustably-attached abutment-ring K, having a variable space,  $v$ , between them, substantially as and for the purpose herein described.

3. The combination of the guide-tube O, the adjustable collar A, screwing upon said tube, and provided with prongs  $d d$ , and the abutment-ring K, held between said prongs, substantially as herein described.

CHARLES FERDINAND DE LA ROCHE.

Witnesses:

EUG. DUBUIL,  
LÉON PECQUET.

(No Model.)

F. BALL, Jr.

ELECTRIC HEAD LIGHT FOR LOCOMOTIVES, &c.

No. 277,536.

Patented May 15, 1883.

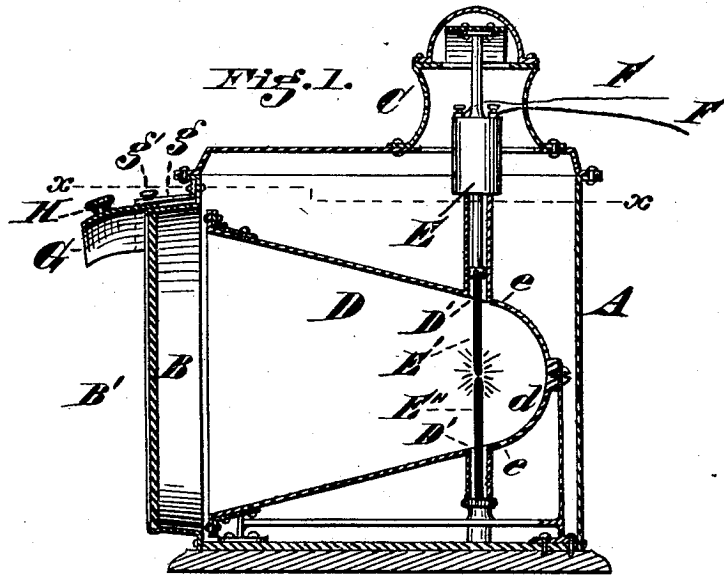


Fig. 1.

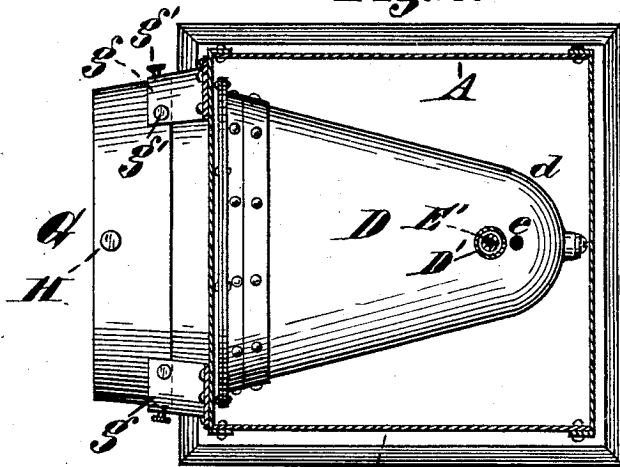


Fig. 2.

Attest  
John Finch  
W. H. Atwell

Inventor  
Flames Ball Jr.

# UNITED STATES PATENT OFFICE.

FLAMEN BALL, JR., OF CINCINNATI, OHIO.

## ELECTRIC HEAD-LIGHT FOR LOCOMOTIVES, &c.

SPECIFICATION forming part of Letters Patent No. 277,536, dated May 15, 1883.

Application filed August 2, 1882. (No model.)

To all whom it may concern:

Be it known that I, FLAMEN BALL, Jr., a citizen of the United States, and residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Electric Head-Lights for Locomotives or other Similar Uses, of which the following specification is a full, clear, and exact description.

This invention has for its objects to provide an improved electric head-light for locomotives and to provide a novel hood for reflecting the rays of light upon the pilot of the engine or upon the track in front thereof. These objects I accomplish by the novel construction and arrangement of parts illustrated in the accompanying drawings, in which—

Figure 1 is a central longitudinal section of a locomotive electric head-light embodying my invention. Fig. 2 is a plan view of the same on line *x x*, Fig. 1, showing the construction and arrangement of the adjustable refracting reflector, peak, or hood.

A represents the case in which the reflector and electric lamp are mounted.

B is the front opening or sight of the same, in which the magnifying-lens B' is secured.

C is a ventilator at the top of case A, preferably immediately above the point where the lamp is to be suspended.

D is the reflector, mounted in any desirable manner, of the usual parabolic or conical form, and having a full, rounded end at its focus, as shown, which forms a highly-reflecting hemispherical shape, as at *d*, to the focus end of the reflector, and being similarly polished within, and by its hemispherical form provides an efficient rear reflecting surface.

D' D' are openings or orifices made in the body of the reflector D, near its rear end, vertically opposite each other, in and through which the carbons of the electric lamp pass, their ends, between which the arc is formed, arriving at a point preferably midway between the openings D' D'.

E represents an ordinary electric lamp, suspended from the ventilator C within the case A, so that its carbons E' E'' shall pass through the openings D' D' made in the reflector D, as hereinbefore set forth. Openings *e e* may be provided in the reflector adjoining the lamp E,

to furnish means for ventilating the same in case the various parts near the lamp should become too highly heated. It will be seen that rays of light will be reflected as usual by the main part of the reflector forward of the lamp, and in addition to this the bulb *d* in the rear of said lamp will form a solid mass of light that will in turn be reflected by the forward main body of the reflector. The efficiency of my improved head-light will readily be seen, very little power being necessary to supply it with electricity to form the light.

F F are wires connecting the lamp E with any desired electric generator or dynamo-machine located on the locomotive and driven by the same power that drives said locomotive.

G represents a longitudinally-arched plate curved downward at its outer edge, (see Fig. 1,) which plate forms a hood which is adjustably mounted in guides *g g* on the upper face of the sight B, as shown, or in the same manner upon the reflector D, so as to be brought forward over the said sight or the mouth of the reflector, being secured in position preferably by thumb-screws *g'*. It is highly polished on its under side similar to the reflector D, and when brought forward to any desired position over the sight or mouth of the reflector it causes the rays of light from the same to refract and fall upon a point just ahead of the engine or vertically upon its pilot to a degree of efficiency never heretofore attained in the use of any other head-light, and is an important feature of my invention.

H is a small knob or button, forming a handle on the hood G, by which to conveniently adjust it.

It is obvious that the hood G can be used in connection with any other construction of head-light than the one herein shown and described; but I prefer its use with my electric head-light in order to augment its utility, and thereby make it as near as possible a perfect head-light.

I am aware that the carbons of an electric lamp have heretofore been extended into a parabolic reflector through side openings therein, the reflector having a short tube of small diameter placed near the light with its axis coincident with the reflected beam; but such I do not claim.

I am also aware that a locomotive head-light has been composed of an exterior casing having a ventilator in its top and containing a reflector through the focus end of which projects an ordinary oil-burning lamp; but such is not my invention.

I claim—

1. An electric head-light for locomotives combining in its structure the exterior casing, A, provided at its top with the ventilator C, and adapted to be attached to a locomotive, the parabolic reflector D, inclosed by the casing and rigidly connected therewith, and having the lens B' and the electric lamp E hung within the casing from a support in the ventilator, and having its carbons extended into the focus end of the reflector through side openings, D', there-

in, said lamp having means for connecting with an electric generator or supply, substantially as described.

2. The combination, with the reflector of a head-light, of the herein-described hood G, adjustably supported in the guides *g g*, said hood being capable of horizontal adjustment, whereby it can be brought forward to any desired position over the sight of the reflector, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

FLAMEN BALL, JR.

Witnesses:

WM. F. NUTT, JR.,  
JOHN J. FINCH.

(No Model.)

3 Sheets—Sheet 1.

W. P. PATTON.  
VOLTAIC ARC LAMP.

No. 311,142.

Patented Jan. 20, 1885.

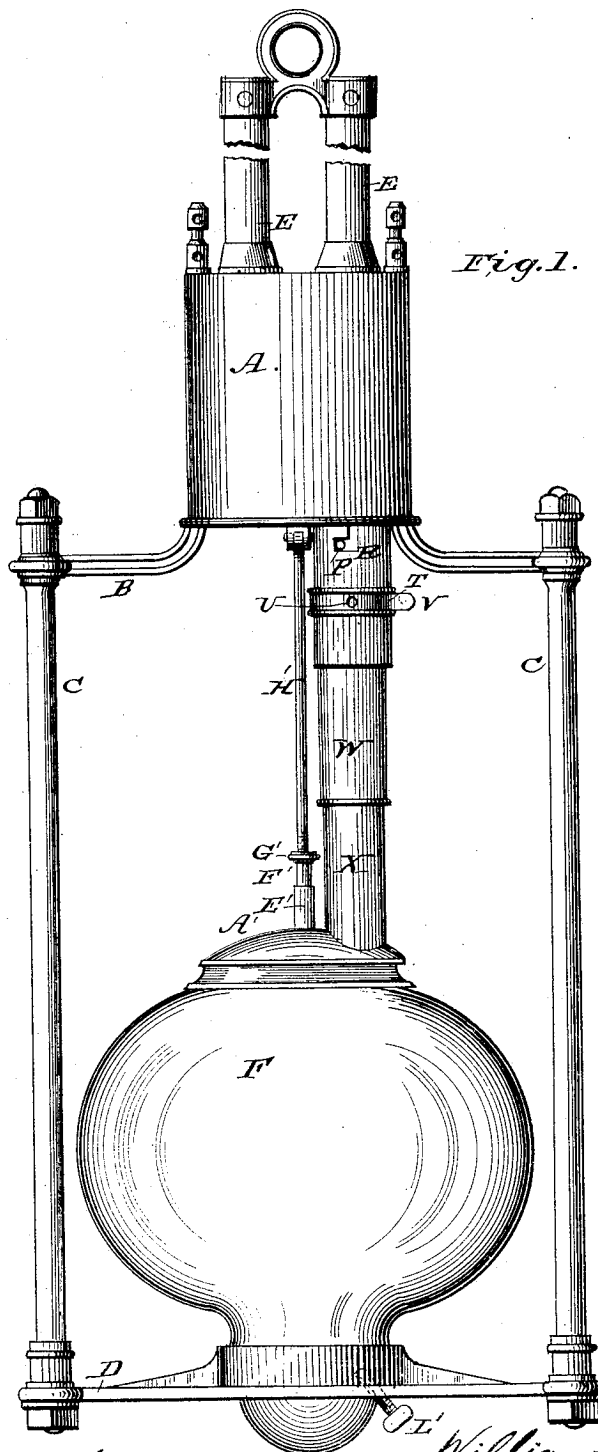


Fig. 1.

WITNESSES:

*Fred. S. Dieterich,*  
*Wm. Bagger*

INVENTOR.

*William P. Patton,*  
*by Louis Bagger & Co.*  
 ATTORNEYS.

(No Model.)

3 Sheets—Sheet 2.

W. P. PATTON.  
VOLTAIC ARC LAMP.

No. 311,142.

Patented Jan. 20, 1885.

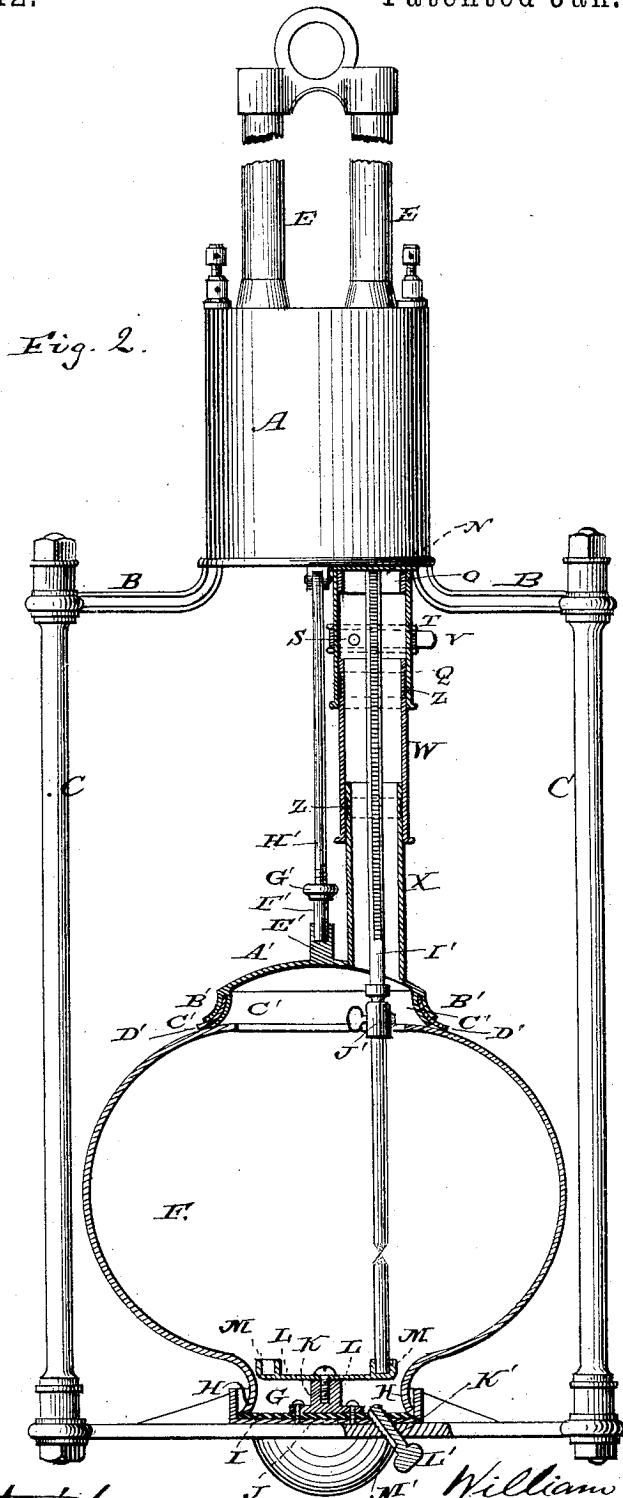


Fig. 2.

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*Wm. Bagges*

INVENTOR.

*William P. Patton*  
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ATTORNEYS.

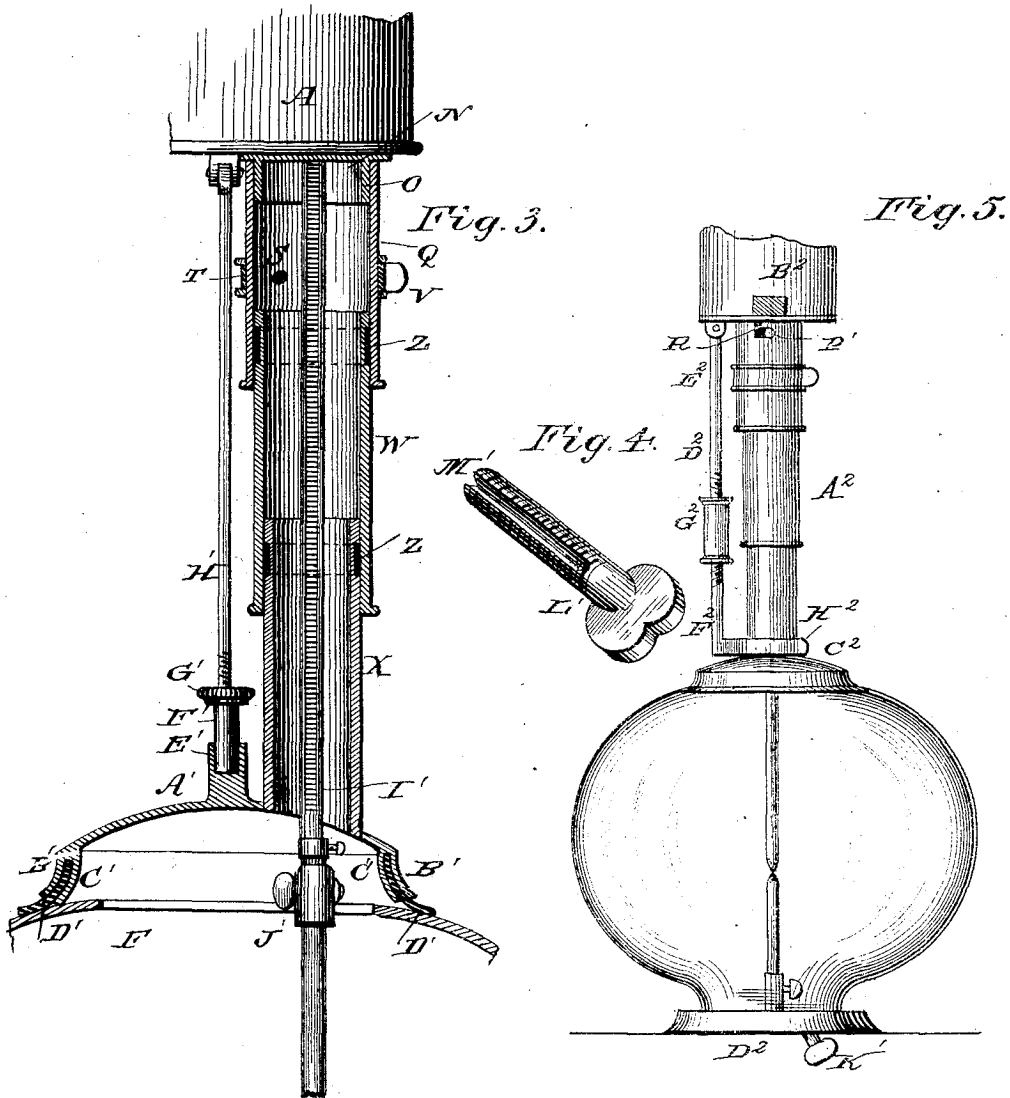
(No Model.)

3 Sheets—Sheet 3.

W. P. PATTON.  
VOLTAIC ARC LAMP.

No. 311,142.

Patented Jan. 20, 1885.



WITNESSES:

*Wm. S. Dieterich*  
*Wm. Bagger*

INVENTOR.

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# UNITED STATES PATENT OFFICE.

WILLIAM P. PATTON, OF HARRISBURG, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO W. E. MACHLIN, OF SAME PLACE.

## VOLTAIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 311,142, dated January 20, 1885.

Application filed May 19, 1884. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM P. PATTON, a citizen of the United States, and a resident of Harrisburg, in the county of Dauphin and State of Pennsylvania, have invented certain new and useful Improvements in Voltaic-Arc Lamps; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification, and in which—

Figure 1 is a side view of an electrical-arc lamp embodying my improvements. Fig. 2 is a similar view illustrating the parts comprising my improvements in section. Fig. 3 is a detail view of the feed-cylinder. Fig. 4 is a detail view of the feed-screw through which air is admitted to the lower end of the globe, and Fig. 5 is a side view illustrating a modification.

The same letters refer to the same parts in all the figures.

My invention has relation to that class of arc-lamps in which the globe is closed air-tight at both ends and provided with a closed casing for the passage of the carbon and its holder from the feed-case; and it consists in the improved construction and combination of parts of the same, as hereinafter more fully described and claimed.

In the drawings hereto annexed, A designates the feed-case of an ordinary arc-lamp. B is the upper frame-bar. C C are the side frame-bars, and D is the bottom bar of the frame which supports the globe. Tubes E E for the carbon-holders extend upwardly from the feed-case A.

F designates the globe, which is preferably of a spherical shape, or nearly so, and which is provided at its lower end with an opening, G, having a flange, H, which rests upon the bottom bar, D, of the frame, between which and the said flange a sheet, I, of rubber or other suitable flexible material, is interposed in order to form an air-tight joint.

Upon the horizontal plate J, which is mounted upon the base-bar D, and which serves to support the globe, is secured a stand-

ard, K, having arms L, provided with sockets M, one of which serves to support the lower carbon point. In the drawings two sockets are shown, but only one set of carbons is used, the other socket serving simply as a reserve socket in the case of an accident.

The under side of the feed-case A is provided with an opening, N, surrounded by a flange or ferrule, O. The latter is provided with a pin, P, by means of which a tube or cylinder, Q, may be detachably connected to the same, the said tube having an L-shaped notch, R, at its upper end, forming what is commonly termed a "bayonet-joint," whereby the said tube may be detachably connected to the said flange. Tube Q is provided about midway of its length with an opening, S, located between two annular flanges, which latter serve as guides or bearings for a revolving ring, T, having an opening, U, which may be made to register with the perforation S, and through which admission of air into the cylinder or tube may be regulated, or, if desired, entirely stopped by simply turning the ring T, which is for this purpose provided with a handle, V.

W and X are tubular sections telescoping within each other and within the upper section, T. These sections are provided at their upper edges with annular grooves or recesses, in which packing Z, of any suitable material, is placed.

For packing I prefer to use soft asbestos, for the reason that this material is not affected by heat, while it will readily retain oil, tallow, or other lubricating material, which is necessary in order to cause the telescopic sections to work freely within each other. The lower section, X, is rigidly connected to the top or cover A' of the globe F. The said cover is concavo-convex in shape, and is provided at its outer edge with two concentric annular flanges, B' and C', between which a ring or washer, D', of rubber or other suitable material, is interposed, the said washer projecting beyond the lower edges of the said flanges, as clearly shown in Fig. 2 of the drawings. It will thus be seen that when the cover is lowered upon the lamp the washer D' will serve to form a joint which is absolutely air-



tight. The cover A' is provided with a centrally-located socket, E', adapted to receive the shank F' of a nut, G', adjustable upon the lower end of a rod, H', which is pivotally connected to the under side or bottom of the feed-case A. It will be seen that by this arrangement, when the holding-nut G' is screwed in an upward direction, so as to release it from the socket upon the lamp-cover, it may be swung out of the way, so as to enable the said cover to be raised or lifted, this being made possible by the telescopic joints or tubes heretofore described. If access to the carbon-holder is desired, (the carbon-holder, which is indicated by letter I', is clearly shown in Fig. 2 of the drawings, and it will be seen that it is provided at its lower end with a carbon-clamp, J', of ordinary construction,) it may be had by detaching the upper telescopic tube from the flange of the feed-box to which it is attached, and this may be done by simply turning the said upper tube so as to release its L-shaped notch from the pin of the holding-flange. The lower frame-bar, B, is provided with an inclined screw-threaded perforation, K', in which is fitted a screw, L', one side of which is flattened or provided with a V-shaped recess, M', as clearly shown in Fig. 2 of the drawings. This screw extends through the rubber washer I, and by it the admission of air to the lower end of the globe may be thoroughly regulated.

From the foregoing description, taken in connection with the drawings hereto annexed, the operation and advantages of my invention will be readily understood.

When it is desired to renew the carbon points in the lamp, this may be done by first releasing the nut G' from the cover and swinging the rod carrying the said nut backward and out of the way. The cover of the lamp may then be raised by the hereinbefore-described arrangement of the tubular and telescoping sections, thus affording free access to the interior of the globe and to the upper-carbon holder.

When it is desired to clean the upper-carbon holder, which is frequently necessary in order to cause its uninterrupted operation, this may be easily done by removing the telescopic tube, which may be accomplished by simply turning its upper section so as to release it from the pin P. The packing I, interposed between the lower support of the lamp-globe and the flange H of the same, serves to take up any expansion of the globe, so as to prevent breakage of the latter. The admission of air to the globe will be regulated not only by the band or rim S upon the upper section of the telescopic cylinder, but also by the feed-screw L' at the bottom of the globe. I thus establish a through current of air without providing an excess of oxygen, so that excessive consumption of the carbon points may be absolutely prevented simply by properly adjusting the air entrance and exit. It will

also be seen that it is utterly impossible for insects or other causes of obstruction to enter the globe.

My invention, as above described, has been shown applied only to a lamp originally constructed to use two sets of carbons; but it is obvious that the invention may be equally well and successfully applied to a single arc lamp by simply making trifling modifications in the construction of details. One way of doing this I have illustrated in Fig. 5 of the drawings hereto annexed, by reference to which it will be seen that the telescopic tube, which is here designated by letter A<sup>2</sup>, is connected centrally instead of eccentrically to the feed-case B<sup>2</sup> and globe-cover C<sup>2</sup>. D<sup>2</sup> is a rod hinged eccentrically to the under side of the feed-case, and composed of sections E<sup>2</sup> F<sup>2</sup>, connected by a right and left hand nut, G<sup>2</sup>, by means of which the lower section may be forced down against the globe-cover, so as to retain the latter securely in position. The said lower section, F<sup>2</sup>, is provided with a horizontal fork, H<sup>2</sup>, straddling or embracing the telescopic tube so as to bear or press squarely upon the globe-cover. The operation of this modification is obvious when reference is had to the foregoing description.

I would have it understood that in many respects this invention may be changed or modified without departing from the principle involved, and that I reserve to myself the right to all such changes and modifications as may be made without departing from the spirit of the invention.

Having thus described my invention, I claim and desire to secure by Letters Patent of the United States—

1. In an electric lamp, the combination of a feed-case, a supporting-frame suitably connected to the same, a globe suitably mounted in the said supporting-frame, an air-tight cover for the said globe provided with a socket upon its upper convex side, a rod pivoted to the under side of the feed-case and having at its lower end a nut, the shank of which is adapted to work or slide in the socket of the air-tight cover, and a telescopic tube connecting the said air-tight cover with a flange upon the under side of the feed-box, substantially as set forth.

2. In an electric lamp, the combination, with a feed-case, the supporting-frame attached thereto, and a globe mounted in the said supporting-frame, of an air-tight cover for the said globe, a telescopic tube connecting the said air-tight cover with a flange upon the under side of the feed-case, the upper section of the said cylinder or telescopic jointed tube being provided with a perforation, as shown, an adjustable gate for the said perforation, and means for admitting regulated quantities of air into the bottom of the globe, substantially as set forth.

3. In an electric lamp, the combination, with a feed-case, of a frame attached to the

5 same and supporting a globe, an air-tight cover for the latter, a central pivoted rod attached to the under side of the feed-case and connected detachably with the center of the air-tight cover of the globe, and an eccentrically-arranged telescopic tube connecting the said air-tight cover with the under side of the feed-case, substantially as set forth.

10 4. In an electric lamp, the combination, with the feed-case having an eccentrically-arranged downwardly-projecting flange or collar, of a tube mounted detachably upon the said collar and provided with an air-admission opening and a regulating-gate, additional tubes telescoping within the said detachable  
15 tube, a globe-cover connected permanently and eccentrically to the lowermost tube, and a suitably-arranged globe, substantially as herein set forth.

20 5. In an electric lamp, the combination of a suitable feed-case, the frame attached to the same, a flanged disk arranged upon the lower frame-bar, a flexible packing-disk arranged

upon the said plate, a grooved or flattened feed-screw extending through the said plate 25 and packing-disk, a flanged globe mounted upon the latter, an air-tight cover for the said globe, a central rod pivoted to the under side of the feed-case, and having a nut whereby the said cover may be tightened against the  
30 upper side of the globe, and a telescopic tube connected detachably to the under side of the feed-case, and having its lower section connected eccentrically to the air-tight cover of  
35 the globe, the upper section of the said telescopic tube being provided with an air-inlet and mechanism for regulating the admission of air, substantially as herein described, for the purpose set forth.

In testimony that I claim the foregoing as  
40 my own invention I have hereunto affixed my signature in presence of two witnesses.

WILLIAM P. PATTON.

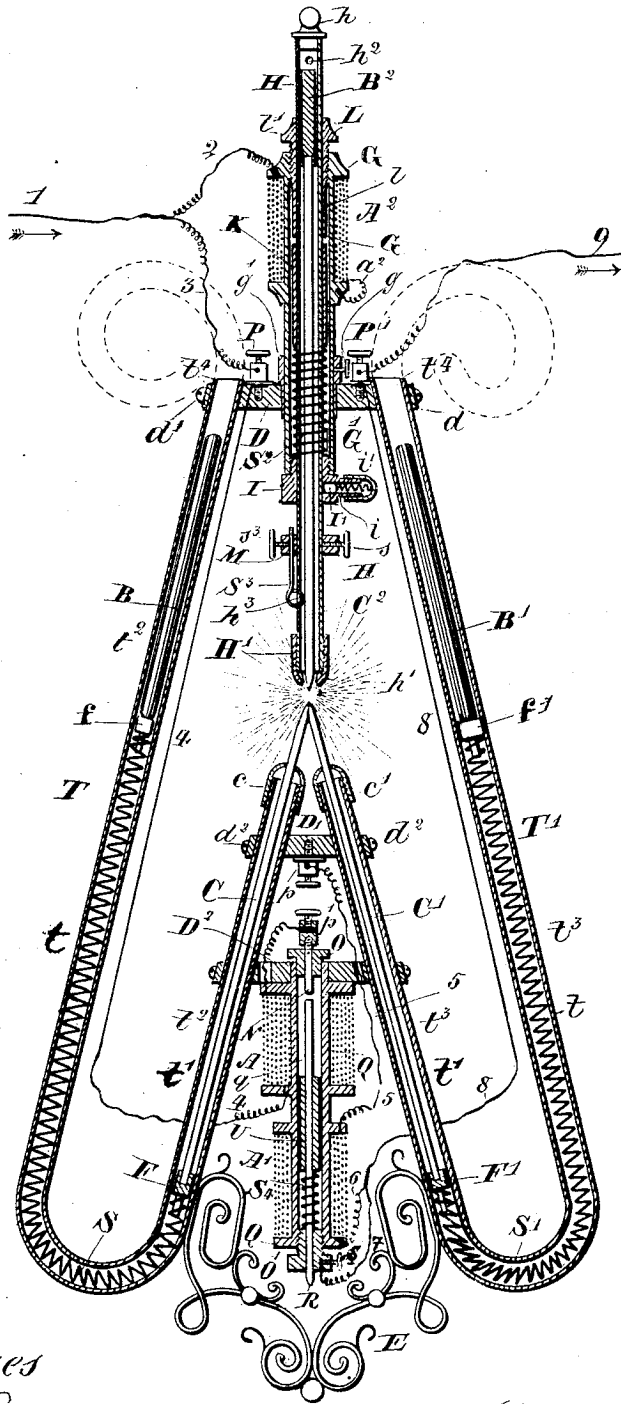
Witnesses:

ANTHONY KING,  
WM. H. CLECKNER.

G. A. TABOURIN.  
VOLTAIC ARC LAMP.

No. 315,571.

Patented Apr. 14, 1885.



Witnesses  
*J. W. Knott*  
*Andrew Plemer*

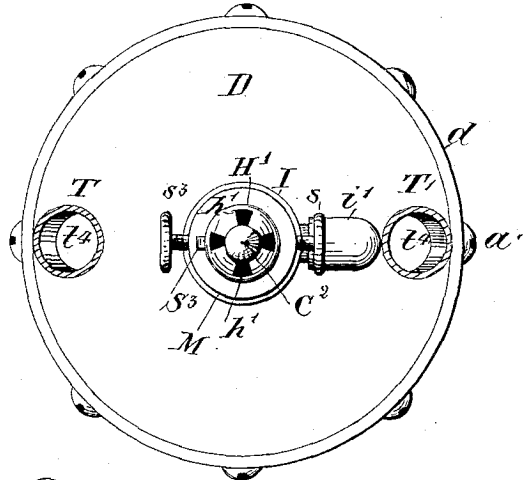
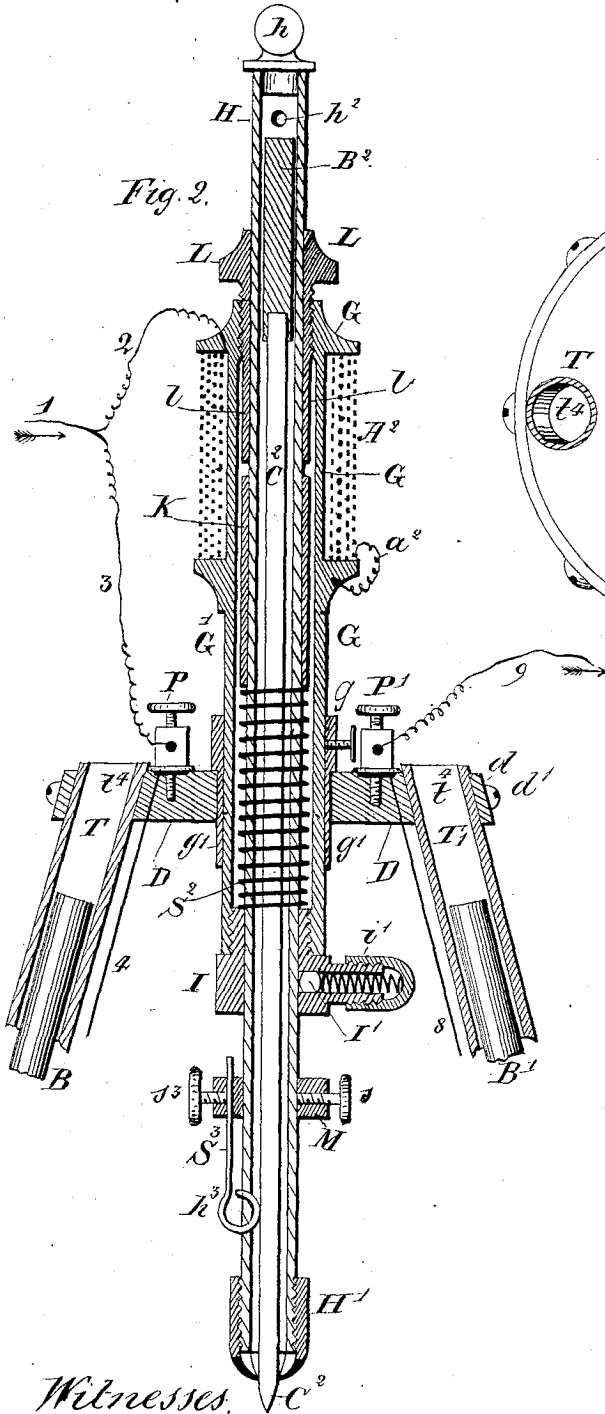
Fig. 1.

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 his att-ty.

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No. 315,571.

Patented Apr. 14, 1885.



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*J. W. Knotts*

Inventor  
*Georges A. Tabourin*  
*per Henry Orth*  
*his atty.*

# UNITED STATES PATENT OFFICE.

GEORGES ANTOINE TABOURIN, OF MARSEILLES, FRANCE.

## VOLTAIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 315,571, dated April 14, 1885.

Application filed March 1, 1884. (No model.) Patented in France November 3, 1883, No. 158,491; in Belgium January 12, 1884, No. 63,819; in Luxemburg January 12, 1884, No. 349; in Austria-Hungary January 19, 1884, No. 12,110/960 and No. 25,181/948; in Italy January 26, 1884, 16,370, and in England January 26, 1884, No. 2,216.

*To all whom it may concern:*

Be it known that I, GEORGES A. TABOURIN, a citizen of the French Republic, residing at Marseilles, in the French Republic, have invented certain new and useful Improvements in Voltaic-Arc Lamps, (for which I have obtained Letters Patent in France, No. 158,491, dated November 9, 1883; in Belgium, No. 63,819, dated January 12, 1884; in Luxemburg, No. 349, dated January 12, 1884; in Austria - Hungary, No. 12,110/960 and No. 25,181/948, dated January 19, 1884; in Italy, No. 16,370, dated January 26, 1884, and in England, No. 2,216, dated January 26, 1884;) and I do hereby declare the following to be a full, clear, and exact description of the invention.

My invention relates to improvements in the construction of voltaic-arc lamps, to the mode of feeding the carbons, and to the arrangement of the latter relatively to each other, as hereinafter fully described, and as shown in the accompanying drawings, in which—

Figure 1 is a vertical transverse section of a voltaic-arc lamp constructed according to my invention. Fig. 2 is a like view, on an enlarged scale, of the upper portion of the lamp, the carbon-holder, and parts connected therewith; and Fig. 3 is an under side plan view of the same.

One of the objects of this invention is to feed the carbons in such manner as to adapt the arc lamp to a greater range of ornamentation than these have hitherto been capable of, and also to entirely conceal from view the carbon-feeding devices.

The further object of the invention is to simplify and increase the efficiency of the carbon-feeding devices and to cause said devices to act with greater precision and rapidity to feed the carbons automatically as they are consumed; and the further object of the invention is to improve the efficiency of this class of lamps.

In the drawings, T and T' indicate two tubular holders bent into U shape, both their longer and shorter legs *t* and *t'*, respectively, being inclined toward each other, the latter, *t'*, having such an inclination that two car-

bons arranged therein and projecting therefrom will meet at their points and form the apex of a triangle. In other words, the inclination of the legs *t* toward each other is such that the projected axial lines thereof will intersect at a fixed point to form the apex of the triangle, such fixed point being the zone of combustion of one of the carbons.

It is obvious that if a carbon is arranged in each leg *t* of the tubular holders, and means provided to project the same from the holder, the points of such carbons will meet at a fixed point and form the apex of the triangle, and if means are provided that tend to constantly force the carbons out of the tube it is obvious that they will remain in contact at all times, whatever the consumption thereof due to combustion may be. In this manner I obtain a fixed point at which the point of one of the carbons of an arc lamp will invariably stand whatever the variations in form or volume of the carbon point may be. Of course it will be understood that the two carbons in legs *t* constitute one of the electrodes of the lamp.

Various mechanical appliances may be employed whereby the two carbons C and C' contained in legs *t* and *t'*, respectively, are forced outward by a power exerted thereon continuously. This may be effected, for instance, by a suitable train of gearing or by cord, pulley, and weight or other known appliances or devices for effecting this purpose.

One of the objects of the invention is to make the lamp as ornamental as possible and to conceal within the ornamentation the operating devices of the lamp. To this end I preferably employ carbon-feeding devices capable of being contained in the tubular arms that serve to support other operative devices of the lamp. The carbons C C' may be fed toward each other by the application of a power exerted thereon uninterruptedly in various ways.

In the accompanying drawings I have shown a very simple arrangement of effecting this, which consists, essentially, of supports that will hold the carbons C C' in contact with each other with a yielding pressure and feed the same as they burn away through the medium

of a power exerted upon their support by an inert body sufficiently more ponderous than the carbon and its support or bearing to overcome the resistance thereof and exert a constant pressure thereon, the tendency of which is to eject the carbons from the tubes, and consequently to maintain the said carbons in constant contact at their points, which is that point at which their axial lines intersect, as stated, or the fixed point of combustion.

As shown, the carbons C and C' are supported in sockets formed in cylindrical heads F F', fitted loosely in the tubes T T', respectively, said heads being secured each to one end of coiled springs S and S', also fitted loosely in tubes T T', respectively. To the opposite end of each spring S S' is fitted a follower, f and f', respectively, upon which rest metallic weights or cylindrical bars B B', respectively. It is obvious that by means of this arrangement of spring feeding devices any desired curvature may be given to the tubes T and T' so long as they are provided with a rectilinear portion at one end for the reception and proper operation of the carbons C C', and a like portion for the reception and proper operation of the weights B B', which latter portion may be at the opposite end of the tubes, or it may be at some point intermediate of two curvatures in the tubes. Consequently the tubes may be bent into any desired form between the two rectilinear portions, t' t' and t' t', or between said portions and in rear of portion t' t', as it is evident that the ends of the tubes at t' may be extended and recurved, for instance, as shown in dotted lines, Fig. 1, by making them in convenient sections, without interfering with the feeding devices, since the springs are sufficiently elastic to adapt themselves to the sinuosities of the tubes without having their functions impaired thereby. At their upper ends the tubes are secured to a bridge or brace, or disk, D, of wood, hard rubber, or other non-conducting material, and they are secured thereto by means of a strap, d, of leather or other suitable non-conductor, and screws d'. Whatever form of brace may be employed, I prefer to recess the same for the reception of the legs t' t' of the tubes T T', though these may be secured in any other desired manner to any suitable or convenient non-conducting retaining device, many ornamental forms of which will suggest themselves to the constructor. Upon this bridge are secured binding-posts P P' for the line-wires, as hereinafter explained. Perforated metallic screw-caps e e' are screwed upon the inner converging ends of the legs of the tubes T T', through which project the carbons, and by which said carbons are properly guided in their movements toward each other, and said tube ends are secured to a metallic bridge or brace or disk, D', to which said tubes are secured by means of a metallic strap and screws d', or in any other preferred or desired manner. To the under side of this bridge,

and in electrical connection therewith, is secured a binding-post, p, for purposes presently explained.

Below the brace D' is located a third brace, D<sup>2</sup>, of wood or other non-conducting material, to which the tubes T T' are secured, and from which are supported two solenoids, A and A', for purposes hereinafter described. At their lower bent portion the tubes may be braced together by any desired ornamental brace, E, as shown, thus imparting to the lamp a graceful and ornamental appearance. The second carbon, C<sup>2</sup>, is also contained within a metallic tubular holder, H, closed at its upper end by an ornamental metallic cap or plug, h. Immediately below the plug h the tubular holder is provided with one or more ports or openings, h<sup>2</sup>, and upon the lower end of said holder is screwed a platinum cap, H', or a cap of some other suitable refractory material, that has an axial perforation of such diameter as to allow the point c<sup>2</sup> only of the carbon C<sup>2</sup> to project through said opening, thereby preventing said carbon from passing out of the tube, except to the extent necessary to produce the arc. The screw-cap H' has a series of ports, h', formed by notches around its axial orifice, and the holder H is of considerably greater interior diameter than the carbon and parts connected therewith, so as to form practically a draft-flue through which upward currents are induced by the heat at the lower end thereof when the lamp is in operation, thereby promoting combustion and increasing the brilliancy of the light.

A<sup>2</sup> is a solenoid connected with the line-wire, and is wound upon a tubular metallic core, G, that has a tubular extension, G', said extension being adjustably secured in a metallic sleeve, g', by means of a set-screw, g, said sleeve being rigidly connected with the brace D. At its lower end, below the brace D, the tubular extension G' of the core of the solenoid A<sup>2</sup> is closed by a metallic screw-plug, I, upon one side of which is a tubular bearing, i, closed by a screw-cap, i', that contains a spring-actuated contact-piece, I', which bears lightly upon the carbon-holder H, that passes through and projects downwardly from said plug I, for purposes presently explained.

The upper annular face of plug I forms a bearing, upon which is seated one end of a coiled spring, S<sup>2</sup>, that surrounds the carbon-holder H, the opposite end of said spring abutting against the annular lower face of a tubular soft-iron armature, K, rigidly mounted upon the carbon-holder H. The upper end of the tubular core G of the solenoid is closed by a tubular screw cap or plug, L, that has an extension, l, projecting into the said core or spindle and inclosing the carbon-holder H, that passes through and projects from the upper end of said plug L, which is provided with a suitable thumb-piece, l', whereby it may be conveniently screwed in and out of core G, the upper end of which is screw-threaded interiorly for the purpose. The carbon C<sup>2</sup> at its

upper end is fitted within a socket formed in a solid metallic bar or rod, B<sup>2</sup>, of such weight as to hold the carbon by a constant pressure in the axial orifice of the screw-cap H', whereby said carbon is automatically fed downward as it burns away. The power of the spring S<sup>2</sup> is so calculated as to nearly counterbalance the weight of the parts suspended therefrom—namely, the holder H and parts contained thereby and connected therewith—said carbon-holder H being arranged relatively to the screw-plug L so as to slide therein. By means of the armature K and the tubular extension of the screw-plug L the distance between the carbon C<sup>2</sup> and the carbons C C' may be adjusted with great nicety—that is to say, the extreme limit to which the point of the carbon C<sup>2</sup> shall be carried away from the carbons C C' may be regulated with great nicety.

To insure perfect electrical connection between the carbon C<sup>2</sup> and the solenoid A<sup>2</sup> through the medium of the carbon-holder H<sup>2</sup>—that is to say, in order to increase the metallic contacting-surfaces between said carbon and solenoid—I employ in addition to the spring contact-piece I', bearing upon the tubular holder, a contact-spring, S<sup>3</sup>, secured by a binding-screw, s<sup>3</sup>, in a metallic collar, M, rigidly connected by means of a set-screw, s, with the holder H at a point intermediate of the screw-cap H' and screw-plug I, in which said tube also slides. The spring terminates in a curl that passes through a slot, h<sup>2</sup>, in holder H, and bears lightly upon the carbon.

As stated, the carbon-holder H and parts connected therewith and contained therein are supported from a yielding or elastic bearing and capable of vertical movement within the supports and core of the solenoid. It has also been stated that the power exerted by said yielding or elastic bearing upon the carbon-holder H and parts connected therewith and contained therein nearly counterbalances the weight thereof, so that but a very slight power is required to lift the holder. It is obvious, therefore, that when an electric current passes through the solenoid the action of the latter upon the soft-iron armature of the holder will be such as to attract the same and relieve the yielding or elastic bearing from a part of the weight of the holder, thereby enabling the former to lift or assist in lifting the said holder. Unless means are provided to limit this upward motion, the attraction of the solenoid and the power exerted by the elastic bearing for the holder would lift the latter so far away from the carbons C C' as to destroy the proper relations between them and the carbon C<sup>2</sup>. The devices for limiting this upward motion have hereinbefore been described, and by their adjustment, as set forth, the limit of upward movement of the carbon-holder can be regulated with the greatest nicety, and a fixed point at which the lamp attains its greatest efficiency can be determined with facility. Other means may be employed whereby this desired result can be obtained—as, for in-

stance, by the adjustability of the collar M upon the tubular holder H, whereby the limit of the upward movement of the holder may be determined with substantially as great facility and nicety; or this may be effected by any other desired or preferred adjustable stop arranged above the screw-plug L in the path of the holder, which stop, when properly adjusted, will determine the limit of the upward movement of said holder.

Having described the general construction and organization of the lamp, I will now describe its electrical connections and its operation.

1 indicates the line-wire or the wire coming from the generator; 2, a branch wire thereof, connected with the solenoid A<sup>2</sup>, and 3 a branch wire connected to binding-post P, which is also connected a wire, 4, that places the solenoid A in electrical connection with the line, one terminal of the solenoid being in electrical connection through binding-post p' with a platinum pin or point, N, secured in a plug, O, of some suitable non-conducting material, fitted in the upper end of the tubular core Q of the solenoids A A', the solenoid A' being connected by wire 5 with the binding-post p on brace D' on the one hand, and on the other with a branch wire, 6, of wire 8, that connects with binding-post P' and line-wire or return-wire 9, a second branch wire, 7, being connected with a plug, O', by means of a binding-screw, s, said plug being screwed into the lower end of the tubular spool Q. The plug O may be made of metal if the spool Q of the solenoid is made of some non-conducting material, as will be readily understood.

As shown in the drawings, the solenoids A A' are wound on a double spool, Q, of metal, and the convolutions thereof are suitably insulated. Into the tubular axial opening q of the spool projects the platinum pin N, as above set forth. Through the plug O' passes a copper rod, R, upon which is rigidly secured an armature, U, of soft iron, said rod and armature being supported upon a spring, S<sup>4</sup>, coiled around the rod, one end of which spring bears against the plug O', the other against the annular face of the armature U, so that the copper rod R is supported by a yielding bearing and free to move vertically within the axial opening of the spool Q and plug O'. The power of the spring S<sup>4</sup> is slightly greater than the power exerted by the weight of the copper rod and its armature, and when the lamp is not in operation or cut out of the circuit the rod R is lifted by the spring into contact with the platinum point.

The number of convolutions of the wire composing the solenoid A, as well as the sectional area of said wire, are so calculated as to offer to the passage of the electric current when said solenoid is called into operation a resistance equal to or slightly greater than the combined resistances of the solenoids A' and A<sup>2</sup>.

When the lamp is not in operation, the carbon point  $C^2$  lies in contact with the carbon-points  $C C'$ , as usual, the weight of the carbon-holder  $H$  being sufficiently greater than the power exerted by the spring  $S$  to overcome the resistance of said spring to its downward motion, as hereinbefore stated—namely, that the power of the spring nearly counterbalances the weight of the carbon-holder and parts connected therewith and contained therein. An electric current coming from a generator, or through line-wire 1, before entering the lamp will be divided, one portion passing to the binding-post  $P$ , the other portion to the solenoid  $A^2$ , one terminal,  $a^2$ , of which is connected with its spool, and through said spool to plug  $I$ , contact  $I'$ , tubular holder  $H$ , contact-spring  $S^3$ , to the carbon  $C^2$ , thence through carbons  $C C'$ , their holders, and the metallic bridge or brace  $D'$ , binding-post  $p$ , wire 5, solenoid  $A'$ , branch wire 6, wire 8, to binding-post  $P'$ , and back to generator or line-wire 9.

As above stated, a portion of the current coming from wire 1 passes by wire 3 to binding-post  $P$ , thence by wire 4 to solenoid  $A$ , the resistance of which, as stated, is equal to or slightly greater than the combined resistance of solenoids  $A' A^2$ , thence by binding-post  $p'$ , platinum point or pin  $N$ , copper rod  $R$ , plug  $O'$ , branch wire 7 and wire 8, where the two currents unite, thence to binding-post  $P'$ , back to generator or to line by wire 9. This electrical condition changes, however, almost instantaneously. As the solenoids  $A^2 A'$  are influenced by the current, the former will attract the armature  $K$  on carbon-holder  $H$ , which latter commences to ascend, thereby increasing the distance between the carbon  $C^2$  and carbons  $C C'$ , developing the arc, while the solenoid  $A'$  attracts the armature  $U$ , drawing the rod  $R$  down against the tension of the spring  $S^4$ , and interrupting the contact between said rod and the platinum wire or pin  $N$ , and owing to the greater resistance of solenoid  $A$ , this interruption takes place before the voltaic arc is developed, thereby preventing the production of sparks at that point. As soon as this contact is interrupted the entire electric current passes through solenoid  $A^2$ , carbon-holder  $H$ , carbon  $C^2$ , &c., to solenoid  $A'$ , and thence by branch wire 7 to wire 8, binding-post  $P'$  to wire 9, as above set forth, the solenoid  $A^2$  attracting the armature  $K$  to move the holder  $H$  and carbon  $C^2$  to the limit of their upward movement, as fixed by the adjustment of the plug  $L$ , when the arc will be fully developed and remain invariable, since said carbon  $C^2$  will be held stationary at that point as long as the required conditions of the electric current remain constant. Should the conditions of the current, however, vary and its power fall below that required to maintain the carbon  $C^2$  at the point of greatest distance from the carbons  $C C'$ , the power of the solenoid  $A^2$  will vary accordingly, and the carbon  $C^2$  will approach the carbons  $C C'$ , thereby di-

minishing the resistance at that point to the passage of the current, as well as the intensity of the voltaic arc, in proportion to the variations in said electric current. Should the passage of the current through the lamp be interrupted by reason of a derangement of any of the devices influenced by the solenoid  $A^2$ , or by a failure from any cause of the passage of the current through tubes  $T T'$ , the solenoid  $A'$  would at once cease to influence the armature  $U$ , leaving the spring  $S^4$  free to act upon it, and carry the rod  $R$  in contact with the platinum pin  $N$ , thereby establishing communication between wires 1 and 9 through solenoid  $A$ , the entire current passing then from said wire 1 through solenoid  $A$  to wire 9 and connections, as hereinbefore described, thus cutting the lamp out of the circuit. It will of course be understood that the solenoids  $A A'$  may have separate spools. For convenience, I prefer to form the two spools of one piece.

Having now described my invention, what I claim is—

1. In an arc lamp, a bent tubular carbon-holder, in combination with feeding devices arranged within the holder and adapted to accommodate themselves to the curvature thereof, as described, for the purpose specified.
2. In an arc lamp, an electrode composed of two carbons, tubular holders for the same, arranged at an angle to each other, and feeding devices consisting of a spring-bearing for the carbons and an inert body arranged to exert constant pressure upon the spring-bearing, substantially as and for the purpose specified.
3. In an arc lamp, an electrode composed of two carbons, in combination with holders for the same, consisting of bent tubes having their legs arranged at an angle to each other for the reception of the carbons, and feeding devices contained within the holders and adapted to accommodate themselves to the curvatures thereof to feed the carbons toward each other and maintain their points in contact, for the purposes specified.
4. The combination, in an arc lamp, with one of the electrodes composed of two carbons  $C C'$ , of the bent tubular holders  $T T'$ , and feeding devices for said carbons contained in said holders, consisting of the elastic supports or bearings  $S S'$  and  $F F'$ , the followers  $f f'$ , and means, substantially as described, whereby a constant pressure may be applied to said follower, for the purposes specified.
5. In an arc lamp, the combination, substantially as described, of one of the electrodes composed of two carbons  $C C'$ , the tubular holders  $T T'$ , bearings or supports  $F F'$ , springs  $S S'$ , followers  $f f'$ , and the weights  $B B'$ , said parts being arranged substantially as described, for the purposes specified.
6. In a voltaic-arc lamp, the combination, with one of the carbons, of a tubular holder therefor arranged relatively to each other to form an annular passage between them open at both ends, and serving as a draft-flue, as described, and for the purposes specified.



7. The combination, with the carbon C<sup>2</sup>, of a tubular holder inclosing the same, except at its point, and having draft-orifices at both ends, whereby an upward draft is induced at the point of incandescence or combustion, substantially as described, for the purpose specified.

8. The combination, with the carbon C<sup>2</sup>, of a tubular holder inclosing the same, except at its point, and having a draft orifice or orifices at its upper end, and the cap H', having an axial orifice of less diameter than the body of the carbon, and draft orifices or ports formed around said axial orifice, substantially as described, for the purpose specified.

9. The combination, substantially as herein described, of carbons C C' C<sup>2</sup>, a tubular holder carrying an armature and inclosing the latter carbon, except at its point, the screw-cap H', the weight B<sup>2</sup>, the solenoid A<sup>2</sup>, in the spool of which said holder is loosely fitted, the screw-plug L, having a tubular extension, l, and the spring S<sup>2</sup>, for the purpose specified.

10. The combination, substantially as herein described, of the carbon C<sup>2</sup>, a tubular holder for the same, a solenoid, in the spool of which said holder is loosely fitted, and a contact-piece connected with and passing through the core of the solenoid in contact with said holder, for the purpose specified.

11. The combination, with the solenoid A<sup>2</sup>, having a spool provided with a tubular extension closed at both ends by tubular screw-plugs, and a tubular carbon-holder fitted loosely within said tubular spool of the solenoid and passing loosely through the screw-caps, and containing the feeding devices for the carbon, of a yielding or elastic bearing for said holder, to limit its movements in one direction by a yielding pressure, substantially as described, for the purpose specified.

12. The combination, in a voltaic-arc lamp, with the two carbons of the lamp, of three solenoids, A A' A<sup>2</sup>, suitable electrical connections between the solenoids and carbons and the main line, and a shunt influenced by the solenoid A', whereby the solenoid A is automatically cut out of the circuit on the passage of an electrical current through said solenoids and through the lamp, substantially as described, for the purpose specified.

13. The combination, in a voltaic-arc lamp, substantially as described, of the two electrodes of the lamp, the solenoids A A' A<sup>2</sup>, the latter having a resistance equal to or greater than the combined resistance of the solenoids A A', suitable electrical connections between the solenoids, the carbons, and main line, and a shunt whereby the solenoid A' is automatically cut out of the circuit on the interruption of the

current through the lamp, for the purpose specified.

14. In a voltaic-arc lamp, the combination, substantially as described, with the solenoids A A', their tubular spool closed at both ends, a platinum wire or point projecting within the spool, and the movable copper rod R, contained and moving freely within said spool, and provided with a tubular armature, and supported from a yielding or elastic bearing, of the carbons of the lamp and suitable electrical connections between said carbons, the solenoids, and the main line, for the purposes specified.

15. In a voltaic-arc lamp, the combination of the carbon-holder H, its armature K, the carbon C<sup>2</sup>, the feeding devices for said carbon, contained within said holder and supported from a yielding bearing, and the solenoid A<sup>2</sup>, surrounding said holder and in electrical connection therewith and with the carbon therein, with the carbons C C', arranged for operation as set forth, the solenoids A A', their electrical connections, and a shunt controlled by solenoid A', said parts being arranged substantially as and for the purposes specified.

16. The combination of the tubular carbon-holders T T', the carbons C C' and means for feeding the same, as described, contained within said holders, the braces D D' D<sup>2</sup>, the solenoid A<sup>2</sup> and the described appliances influenced thereby and connected therewith, the solenoids A A' and the described appliances influenced thereby and connected therewith, and the electrical connections 1, 2, a<sup>2</sup>, 3, 4, 5, 6, 7, 8, and 9, said parts being arranged for co-operation substantially as and for the purposes specified.

17. The combination, with the solenoid A<sup>2</sup>, its tubular spool G, having extension G' and the described parts connected therewith, and the tubular holder H and the described parts connected therewith and contained therein, supported from the spool of the solenoid, of the sleeve g, and bridge or brace D, and means for adjusting the solenoid in said sleeve, substantially as specified.

18. The combination, with the carbon-holder H, the carbon C<sup>2</sup>, and the contact-spring S<sup>3</sup>, of the solenoid A<sup>2</sup>, the tubular spool G thereof, having extension G', the screw-plug I, having a tubular projection, i, and the spring-actuated contact I', contained in said projection, said parts being arranged for co-operation substantially as specified.

In testimony that I claim the foregoing I have hereunto set my hand this 28th day of December, 1883.

GEORGES ANTOINE TABOURIN.

Witnesses:

CAMILLE CHARROPPIN,  
EMILE KANTER.

(No Model.)

4 Sheets—Sheet 1.

W. H. MILLER.  
ELECTRIC ARC LAMP.

No. 376,007.

Patented Jan. 3, 1888.

Fig. 1.

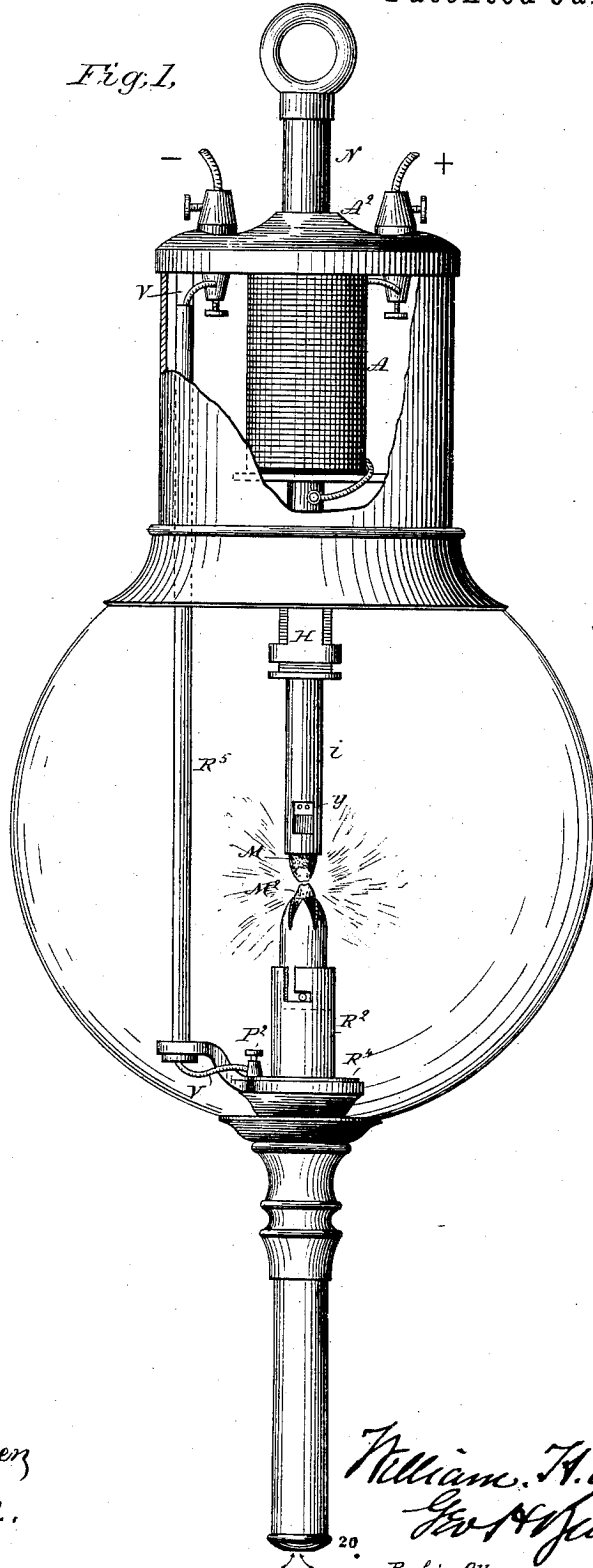


Fig. 2.

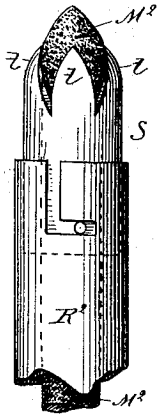


Fig. 3.

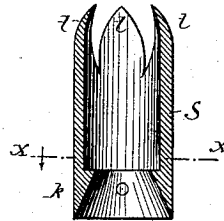
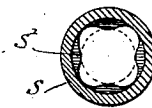


Fig. 4.



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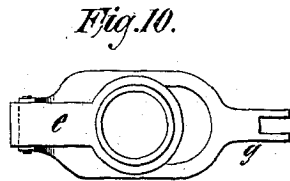
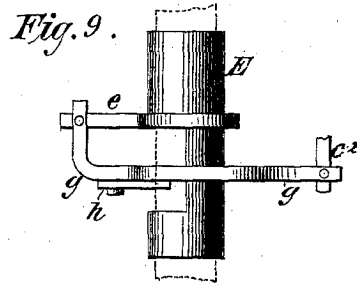
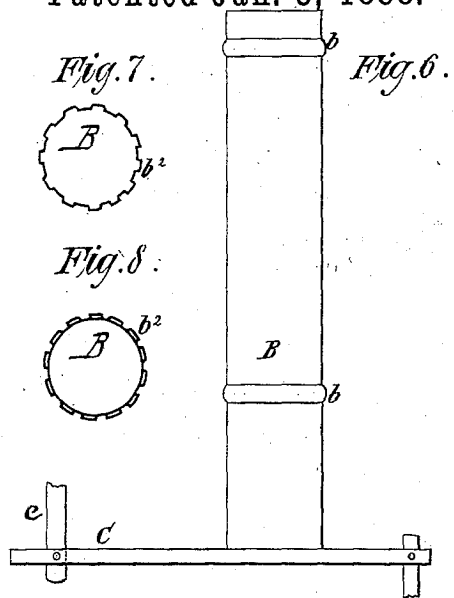
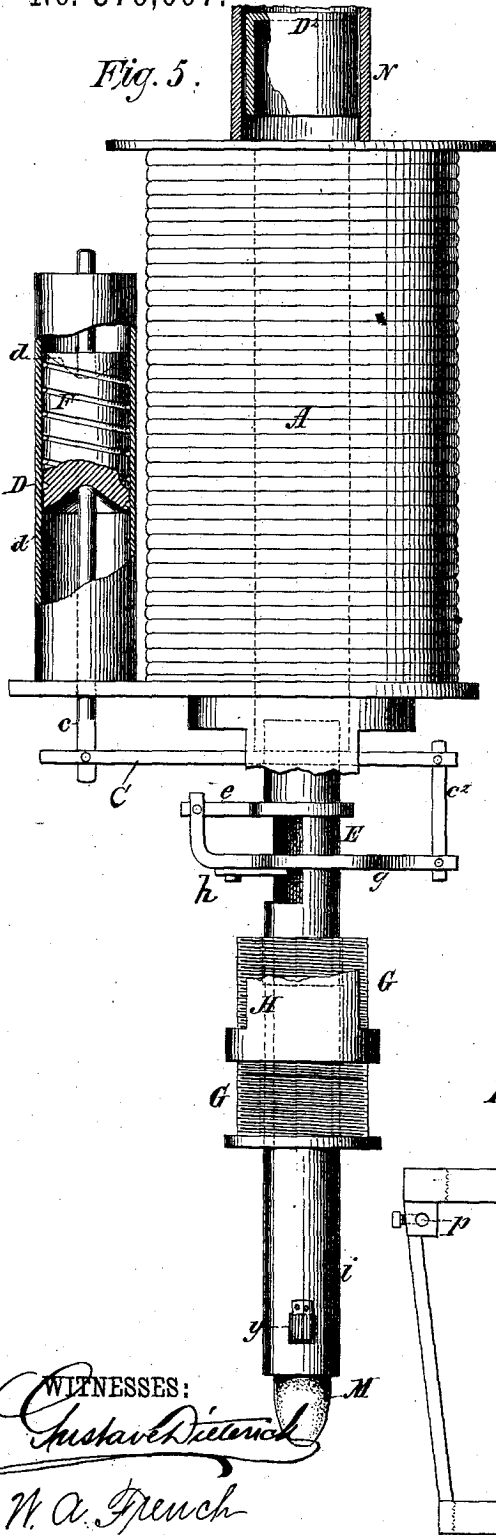
(No Model.)

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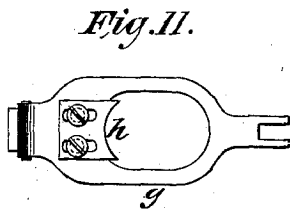
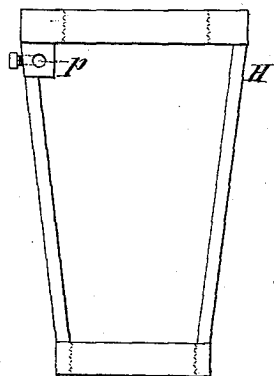
W. H. MILLER  
ELECTRIC ARC LAMP.

No. 376,007.

Patented Jan. 3, 1888.



*Fig. 12.*



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4 Sheets—Sheet 3.

W. H. MILLER.  
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Patented Jan. 3, 1888.

Fig. 13.

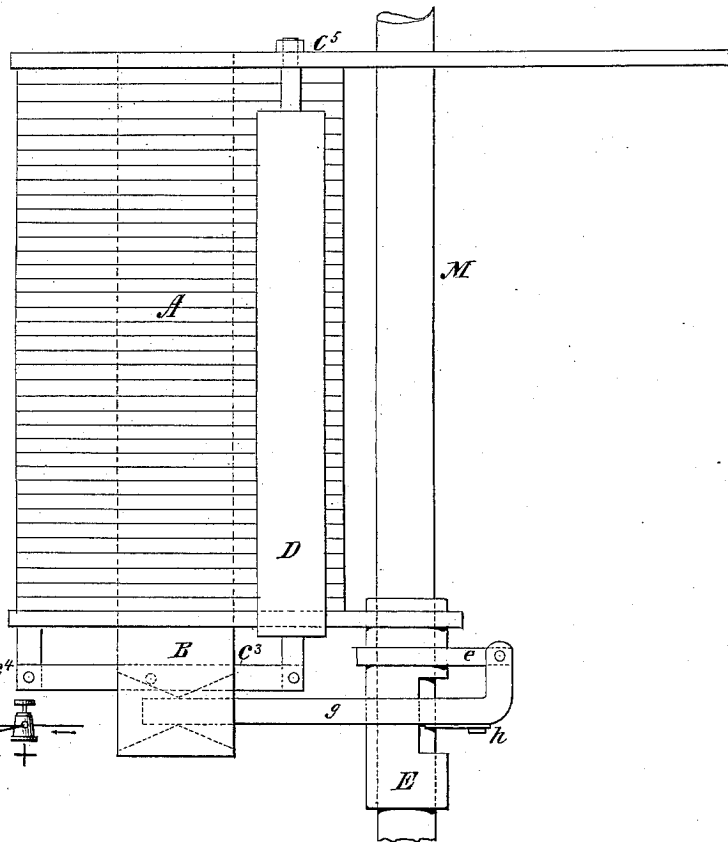


Fig. 24.

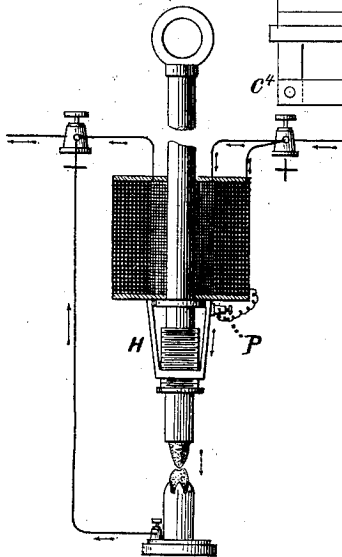
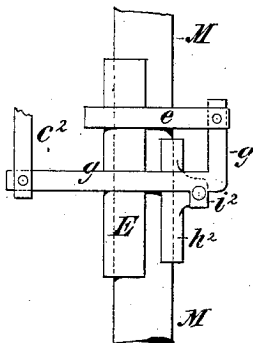


Fig. 14.



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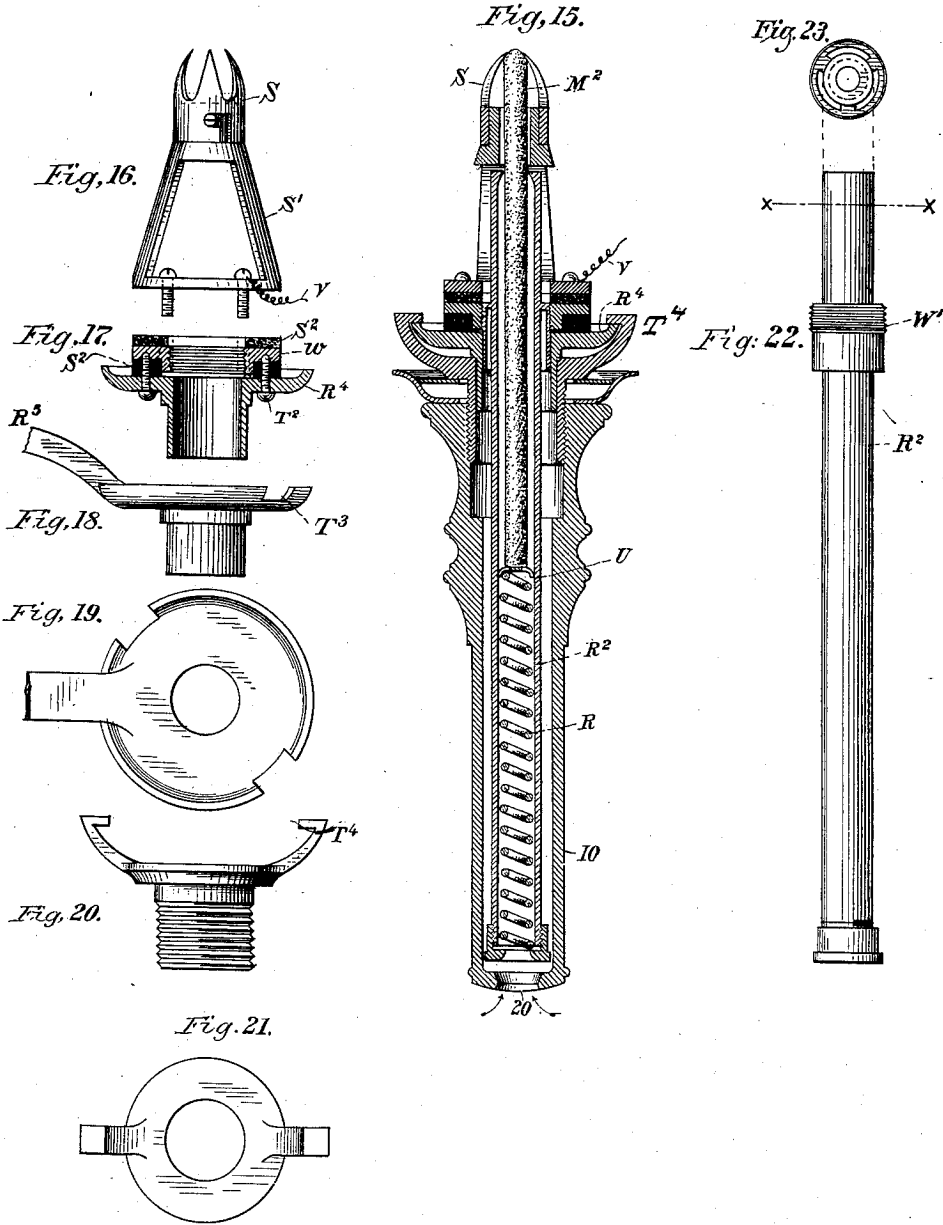
(No Model.)

4 Sheets—Sheet 4.

W. H. MILLER.  
ELECTRIC ARC LAMP.

No. 376,007.

Patented Jan. 3, 1888.



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By his Attorney:

# UNITED STATES PATENT OFFICE.

WILLIAM H. MILLER, OF NEW YORK, N. Y.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 376,007, dated January 3, 1888.

Application filed June 16, 1884. Serial No. 135,068. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM H. MILLER, of the city, county, and State of New York, have invented a new and useful Improvement in Electric-Arc Lamps, of which the following is a specification.

My invention relates to that class of electric-arc lamps in which the voltaic arc is maintained at one unvarying position during consumption of the electrodes, thereby producing what is commonly known as a "focusing-lamp."

The novel combination of parts and devices and the improvements in the details of construction that constitute my invention will be first described with relation to the drawings, and will then be specified more particularly in the claims.

In the accompanying drawings, forming a part of this specification, similar letters of reference represent like parts.

Figure 1 is a front elevation of a lamp embodying my invention, parts being broken away in order to better show the construction. Fig. 2 shows in elevation the guide and feed governing abutment for the lower or negative carbon. Fig. 3 shows a vertical section one form of my improved abutment sleeve or tube. Fig. 4 is a horizontal section on the line *xx* of Fig. 3. Fig. 5 shows in elevation the upper portion of the lamp enlarged, the novel dash-pot construction being shown in partial section. Fig. 6 is an elevation of the magnet-core and armature. Figs. 7 and 8 are cross-sections of modified forms of magnet-core. Fig. 9 is a detail view of the clutch or clamp in elevation. Fig. 10 is a plan view of the same. Fig. 11 shows the clutching or gripping lever from the under side. Fig. 12 is an elevation of a frame for supporting certain detail parts. Fig. 13 is an elevation of a lamp having a modified disposition of the feed-regulating magnet. Fig. 14 shows in elevation a modification of the clutch. Fig. 15 is a vertical section of the lower-carbon holder. Fig. 16 is an elevation of the yoke supporting the abutment-piece. Fig. 17 is a vertical section of the cup which supports the yoke or saddle, and shows the interposed rings of non-conducting material. Fig. 18 is an elevation of the cylindrical base or cup forming a part of the frame of the lamp, and which supports the

lower-carbon holder. Fig. 19 is a plan view of the same. Fig. 20 is an elevation of the connecting ring-clutch, to which the inclosing-tube at the base of the lamp is connected. Fig. 21 is a plan view of the same. Fig. 22 is an elevation of the tube which contains the carbon and its actuating-spring. Fig. 23 is a transverse section of the same, taken on the line *xx* of Fig. 22. Fig. 24 is a view of a modification, showing the application of the yoke *H* to the solenoid and the electrical connection therewith, and also the electrical connections with the lower carbon.

*A* indicates a differential electro magnet of any desired construction, attached in any suitable manner to the upper plate, *A'*, of the lamp, and by preference having a hollow movable core, *B*, for the passage of the upper or positive electrode of the lamp, said core being arranged to work up and down in tube or cylinder upon which the coils of *A* are wound. The coils upon *A* are supposed to be the usual main and derived circuit coils of an electric lamp, said main-circuit coils being of coarse wire and in circuit with the electrodes and arc, while the derived-circuit coils, which are of fine wire, are so wound and connected as to oppose or tend to counteract the influence of the main-circuit coils and in a branch or derived circuit of high resistance around the arc. Said main-circuit coils act upon the well-known principle to raise the core, and by suitable intermediate mechanism to lift the upper electrode, while the derived-circuit coils cut down the lifting-power as the arc increases in length, so as to finally cause the lifting action to cease, to then cause a lowering of the core, and finally permit the core to drop so far as to cause a release and feed of the upper electrode to take place. The core *B* of the solenoid is, as already remarked, made hollow to allow the carbon to pass through it, and works in a guiding tube or way (not shown) within the solenoid. In order to reduce the number of bearing-points between the core and the tube, and to avoid friction as far as possible, said core is provided with two or more beads or projecting rings, *b*, which constitute the only parts of contact or bearing between the core and the tube in which it moves, which may be either worked out of the metal of *B* or they may be separately formed beads or rings

attached to said core. Instead of transverse beads or rings, the core may be provided with longitudinal flutings, ribs, or corrugations worked out of the material or attached to the core B, as indicated at  $b^2$   $b^2$ , Figs. 7 and 8, showing such modified forms of core in cross-section, or the internal surfaces of the solenoid-tube carrying the coils may be fluted or ribbed for the same purpose, as indicated in Fig. 24, where the core-tube and solenoid are shown in transverse section. In both such arrangements the body or main portion of the core is kept out of contact with the tube, and the friction of the parts is reduced to a minimum.

Attached to the end of core B, in any suitable manner, is a cross-bar, C, one end of which connects with the plunger-rod  $c$  of an air dash-pot, D, which latter is mounted on a platform formed by extending the head of the magnet-spool, or upon other suitable support. The other end of the bar C is connected by a link,  $c^2$ , with suitable lifting and adjusting mechanism for the upper or positive electrode, M, of the lamp, preferably of the form to be presently described.

On the plunger F of the dash-pot I provide a spiral groove which surrounds the plunger, but which ends blindly and does not connect the air-spaces above and below the plunger, while in the ends of said plunger, which is guided at both ends of the dash-pot, are the depressions or inverted cup or cone shaped cavities marked  $d$ . The object of this arrangement is, by means of the air-packing of the plunger, (the air contained in the spiral groove serving as a packing in the manner well understood,) to increase the resistance of the parts without mechanical friction, and to thus check any sudden movement of the core and of the electrode M, supported and controlled thereby. The lifting and feed-adjusting mechanism for the electrode M consists of a sleeve or barrel, E, guided vertically in line with the carbon M, so that it may act properly as a guide for the same, and carrying a gripping or clutching dog or toe,  $g$ , pivoted on extension  $e$  from said sleeve, and connected by link  $c^2$  at its opposite end with the cross-bar C and the movable magnet-core. The gripping or engaging surface of the dog  $g$  consists of a block,  $h$ , of any suitable material, preferably of steel, which is attached to  $g$  by screws passing through slots in the block, so as to permit an adjustment of the block with relation to the carbon electrode M, or carbon-carrier, against which it impinges through an opening in the sleeve or guide E. The clutching dog or toe is brought into engagement with the electrode by the raising of its end connected to link  $c^2$  at the opposite side of the electrode from the gripping-surface. The block  $h$  might be formed in one piece with the lever  $g$ , if desired. If the magnet be placed to one side of the electrode, the lever  $g$  might be connected directly to its core. The barrel or sleeve E is guided at its upper end by fitting into the end of the core B, or by fitting into or onto the end

of the guide-tube in which the core moves, or by other suitable device. Its lower end is similarly guided by fitting into a recess in the end of a hollow screw, G, which acts both to determine the point at which, in the downward movement of the core, the clutch shall release the electrode, and also serves with or without an attached tube to guide the electrode. The said screw G works in the bottom cross-bar of a frame, H, the upper end of which latter is suitably secured to or supported from the end of the magnet by screwing it onto the tube upon which the coils are wound, or upon a boss formed on the spool-head, as may be desired. When the clutch-lever  $g$  is lifted by the core, the gripping-block  $h$  is made to bear against the side of the electrode M and holds the latter against the internal surface of the sleeve E, and, if further lifting movement ensue, the sleeve E is raised vertically in its guideways, thus lifting the electrode M to form an arc at starting or to increase the length of the arc upon an increase of current flow on the circuit. When the sleeve and pivoted dog  $g$  are lowered, the sleeve finally comes to rest upon the bottom of the guide or recess for it in the screw G, and the movement of the clutch-lever  $g$  is then such as to disengage the electrode, which latter then feeds downward under the action of gravity. By thus arranging the guided sleeve and the pivoted clamping dog or toe the electrode will be held against the flat side of the clamp-tube and cannot be thrown out of perpendicular through tilting or swinging movement of the latter to one side. As the power applied to the pivoted dog  $g$  is applied to the long arm of the lever and the gripping jaw  $h$  is between the fulcrum and the point of application of the power, a firm grip is produced without possibility of slip. By giving the lever  $g$  a bent form, as shown, I secure a rapid or increased movement of the clutch-block  $h$  to and from the electrode, the result being a very sensitive and delicate action without danger of overfeed or a flaming arc, due to roughness or dirt on the surface of the electrode or arc, and therefore a very gradual feed movement and steady light. The clutch device, as a whole, allows the utmost freedom of movement of the electrode in the lifting action of the magnet, but renders a downward movement impossible, except when permitted by the meeting of the sleeve E with the adjusting-screw G. It is obvious that, so far as the clutching action of this device is concerned, the side of the sleeve or tube opposite the gripping-block  $h$  is the effective surface, and it is therefore expedient to cut away one side of said tube and make it semi-cylindrical, as indicated.

In Fig. 14, where the parts are shown reversed, instead of a gripping block or clutch surface such as  $h$ , a grip or dog in the form of a shoe,  $h^2$ , conformed to the rod or electrode, may be employed, said shoe being loosely pivoted to the clutch-lever  $g$  at  $i^2$ , as indicated. This form is in principle the same as that al-

ready described. The half tube E would be guided as before, and it, with the pivoted shoe  $h^2$ , would serve to guide the electrode M. The shoe  $h^2$  may be regarded as a half of the tube and as interposed between the gripping-block constituted by the point of bearing of the lever upon the shoe and the electrode M. The shoe may be balanced so as to always retain a perpendicular position, so that it will move bodily away from the electrode, or it may be balanced so that its upper end will fall inward against the electrode, thereby assisting in giving a downward movement to the electrode when the part E comes to rest. The internal surface of the shoe  $h^2$  may, if desired, be roughened, toothed, or serrated, in order to assist it in taking hold of the electrode and carrying it downward in case gravity alone acting on the electrode should not be sufficient. It is essential to the operation of the clutch that the gripping-lever  $g$  be pivoted at one extremity and the lifting mechanism at the other, and the gripping-block itself affixed to the lever at a point between these two points, or at or near the angle of the lever. The lifting mechanism must be attached to the long arm of the lever, and the gripping-block form the short arm. The release of the carbon will thereby be produced by arresting the motion of the tube E, so that the motion of the grip at the instant of impact and release is always in the direction to assist the movement of the electrode. In many of the clutching devices now in use this movement of the electrode is reversed, and at the instant of impact between the electrodes and the grip the electrode is forced downward, in order to produce a firm grip, and at the instant of release the electrode has to be lifted to a like extent in order to effect its release. This condition I have found to interfere with the sensitive action of the lamp.

In the modified disposition of the parts shown in Fig. 13 the magnet is to one side of the electrode M and the latter moves through suitable guides independent of the core B or the guide-tube for the latter. In this form the clutch-lever  $g$  is connected directly with the end of the core B, the latter having an opening provided with the double knife-edges, between which the end of lever  $g$  rests. A lever,  $e^3$ , pivoted in a bracket,  $e^4$ , and provided with a pin or stud resting on an inclined surface in the core, imparts movement to the cylinder of the dash-pot D, the plunger-rod of said dash-pot being supported from the cross-piece  $e^5$ . The screw G, while serving as a guide for the electrode, also serves to bring the electric current to the electrode at a point near the arc and to thus diminish the resistance interposed by said electrode, while at the same time (by reason of the fact that the lower carbon is made to feed upward as it consumes, so as to keep the arc always at the same point) it serves to keep the resistance constant. To this end the screw G is made of metal and is kept in constant electrical connection with the

electrode by means of suitable contact-springs,  $y$ , connected to the screw or to a downwardly-projecting tube,  $i$ , of metal, forming also a guide for the electrode. The springs  $y$  are preferably applied to the electrode at a point as near as practicable to the arc, so as to bring the current directly to the electrode near its end.

$D^2$  indicates a cup of insulating material that fits loosely in the tube N, projecting above the lamp for the reception of the upper end of the positive electrode. Said cup is adapted to rest loosely on the top of the magnet or other support and over the tube or guide in which the electrode moves. When an electrode is inserted, the cup is picked up thereby, and, while the end of the electrode or holder therefor remains in the tube N, insulates the tube and electrode from one another.

$M^2$  indicates the lower or negative carbon or electrode of the lamp, and  $R^2$  a tube or guide in which said electrode or electrode-holder moves upward under the action of a spring, R. Arranged over the top of the spring, and between it and the electrode, is a follower, U, made of any non-conducting material—such for instance, as asbestos.

S indicates an abutment-piece, against which the electrode is constantly forced by the action of the spring, and that is suitably formed to permit said electrode to be moved gradually upward as its end wastes in the arc. The abutment S may be arranged on the tube  $R^2$  or upon a yoke,  $S'$ , as shown in Figs. 15 and 16, and the yoke mounted upon the non-conducting ring  $S^2$ , supported in the base-cup T, the object of this arrangement being to prevent the heat of the arc from being conducted downward to the carbon holder and spring. The abutment should be constructed to allow the electrode to project normally from one-fifth to three-eighths of an inch, sufficient to prevent it from casting any shadow and to secure the abutment from being destroyed by the action of heat. I prefer to construct the abutment, as shown, from a tube or sleeve made of any suitable material not readily destroyed by heat, preferably iron, and to provide it with three or more introverted serrations, teeth, or points,  $t$ , for the electrode to press against, which teeth, if accidentally destroyed, may be repointed from the material of the tube and bent inward to proper position, said process being repeated until the tube S is consumed. The lower end of the tube S may be counter-bored, as shown in Fig. 3, so as to form a guide, collar, or neck at  $k$  of proper size to allow passage of the electrode, or it may be formed as shown in Figs. 15 and 16, where the abutment-tube S fits over the neck of the saddle  $S'$ , the object in either case being to cause a second electrode in the tube to follow the first squarely and allow the last quarter-inch or less to be consumed, the one piece passing out and the next following with a barely-perceptible flicker in the light; and also, by reason of the air-space between the electrode and the upper part



of the abutment-piece, to preserve the latter and to prevent the otherwise rapid conduction of heat to the guide-tube and actuating-spring. The abutment is removably attached to the tube R<sup>2</sup> or saddle S' or other support by a bayonet-joint or other attachment, and may be, therefore, readily removed and replaced when desirable, as for repairs, or for the purpose of inserting a new electrode from the top of the tube. The electrode may, however, be inserted from the bottom, and for this purpose the bottom of the tube is provided with a removable stopper, U', perforated to allow ingress of air.

Between the rings of non-conducting material, S<sup>2</sup>, I arrange the metallic ring *w*, which is provided with a screw-thread in its inner circumference and adapted to receive the screw *w'* on the tube R<sup>2</sup>, thus allowing the tube to be adjusted relatively to the abutment-piece S on the top of the saddle. The ring *w* is adjusted so as not to touch the plate or flange R<sup>1</sup> by means of the screws T<sup>2</sup>. Cut in the periphery of the plate or flange R<sup>1</sup> are the notches T<sup>3</sup>, which are adapted to receive the jaws T<sup>1</sup>, arranged on either side of the connecting-ring Y. Attached to the connecting-ring by means of a screw at its end is the inclosing-tube 10, which is provided with an orifice, 20, at the bottom, through which the air enters, thus producing a circulation through the tube and tending to keep it cool.

The various forms are explained by the drawings.

The mode of connecting the various portions of the lamp will be understood more readily by reference to Figs. 1 and 24. The positive binding-post of the lamp is indicated by the sign + and the negative by the sign -. From the former connection is made directly with one terminal of the coarse wire on the magnet A, the opposite terminal being connected by a binding-screw at P on the frame H, through which and the screw G, tube *i*, and springs *y* electrical connection is made with the positive electrode M. Current flows from the latter through the arc to the negative electrode M<sup>2</sup> when the lamp is in action or the electrodes in contact, and from the latter through the teeth of the abutment, the spring R, and tube R<sup>2</sup> to the binding-post P<sup>2</sup>, mounted on and not in electrical connection with the flange or plate R<sup>1</sup>, into which the tube screws, with which it is otherwise suitably connected. Flange or plate R<sup>1</sup> is carried by a hollow rod, R<sup>3</sup>, depending from the lamp-frame, and connection is made with the negative binding-post by an insulated wire, V, passing up through said rod and connected with the post P<sup>2</sup> and the negative binding-post. The fine wire or derived-circuit coil is in a connection from one post, +, to the other, -, as indicated, and therefore forms a branch or derived circuit of high resistance around the arc, as usual.

In the operation of the lamp the arc is formed in the usual way by the lifting action of the main-circuit coil on the upper elec-

trode, and is maintained by the releasing or feeding action of the oppositely-acting derived-circuit coil, combined with the automatic feeding of the lower carbon as controlled by the abutment, which permits the latter to move upward as it consumes, thus maintaining the arc at the same point. When the upper electrode has fed down out of engagement with the clutch, it simply falls away from the same and into contact with the lower electrode, being maintained in upright position by the guide sleeves and tubes described. In such position it forms a short or low resistance path for the current for the lamp. The end of the upper electrode may be transferred to the lower holder or tube and serve as a negative electrode.

By my construction of lamp and arrangement of parts I may decrease the length of lamp to nearly one-half of those in ordinary use, or I may employ an electrode of twice the length; and thereby double the interval of time between recarbonings. A usual length of lamp, as lamps are now made, is fifty-four inches, and the length of the positive carbon consumed nine and one-half to ten inches. This length of lamp I reduce to twenty-five inches, consuming same length of carbon, or to forty inches, consuming eighteen inches of positive carbon.

What I claim as my invention is—

1. The combination, in an arc lamp, of the open-bottom tube 10, the open-bottom tube R<sup>2</sup>, provided on its upper end with a bifurcated abutment for the lower carbon, an open or spider shaped follower, and a spring for lifting the said carbon, with the upper carbon controlled in its downward movement by a clutch connected with the stem of the dash-pot, substantially as described.

2. The combination, in an arc lamp, of a differential electro-magnet and upper carbon sustained therein, a clutching device, a dash-pot having a grooved plunger centered upon a stem connected to said clutching device, and a lower-carbon spring actuated and adjustable in a guided tube open at its lower end and provided with a sleeve, W', substantially as described.

3. In a focusing arc lamp, the combination of two electrodes, one a spring-actuated electrode inclosed by an open-bottom tube provided with a detachable feed-controlling abutment at its wasting end attached to a saddle, S', and the other a gravitating electrode provided with carbon separating and feeding mechanism, a clutching device controlled by a dash-pot having a spirally-grooved plunger, and an actuating or controlling magnet, substantially as described.

Signed at New York, June 11, 1884.

WILLIAM H. MILLER.

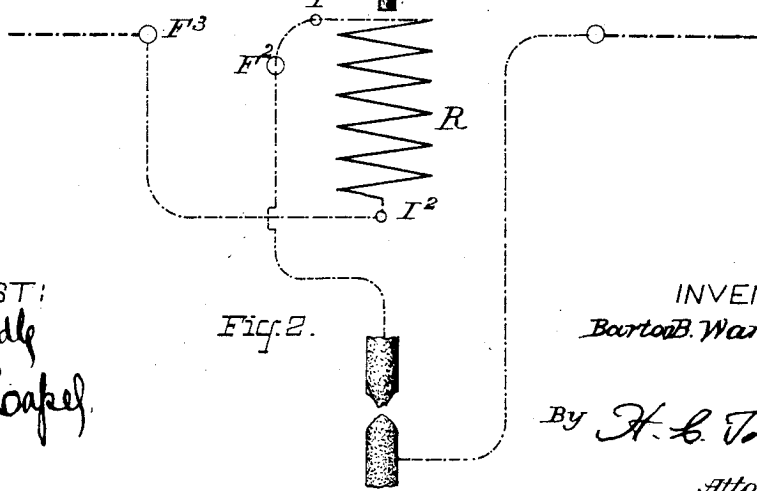
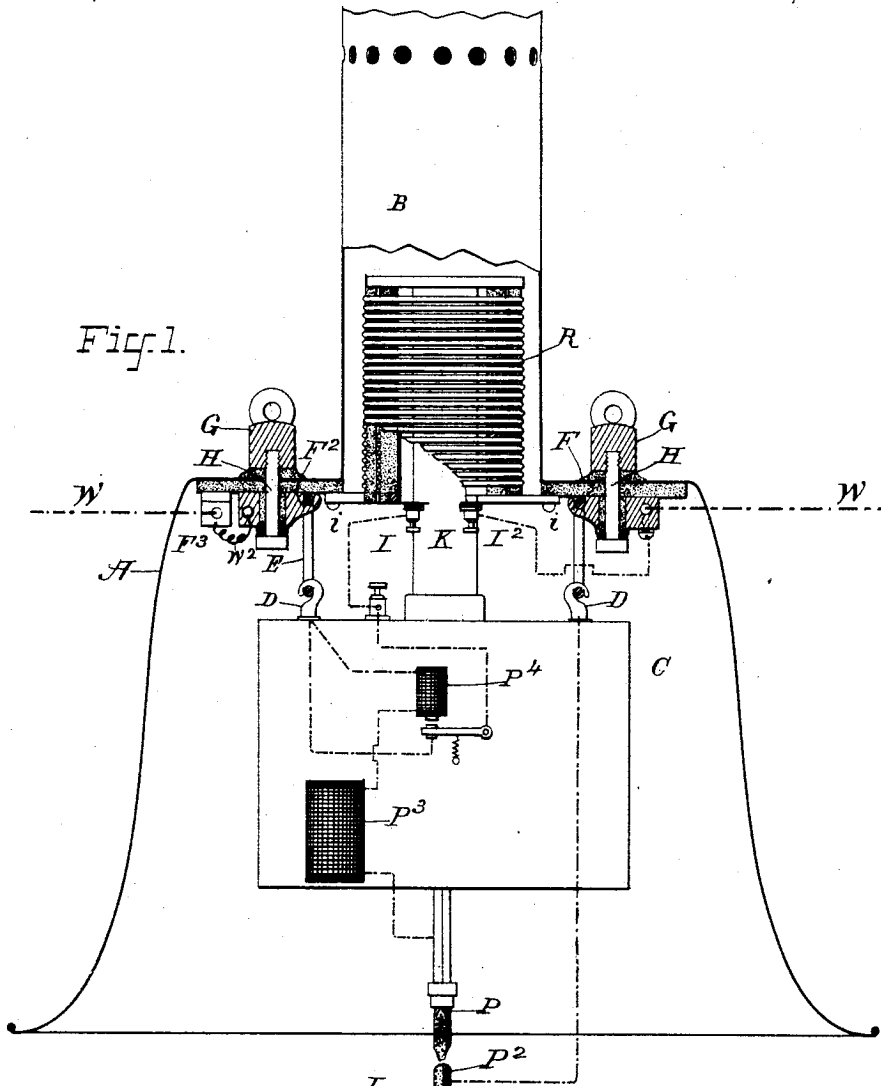
Witnesses:

W. A. FRENCH,  
C. W. BENJAMIN.

B. B. WARD.  
ELECTRIC ARC LAMP.

No. 444,473.

Patented Jan. 13, 1891.



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*J. Mundy*  
*Wm. H. Cooper*

INVENTOR:  
*Barton B. Ward*

By *H. L. Townsend*  
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ELECTRIC ARC LAMP.

No. 444,473.

Patented Jan. 13, 1891.

Fig. 3.

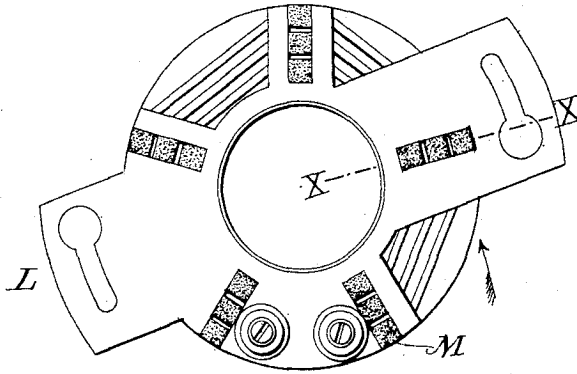


Fig. 4.

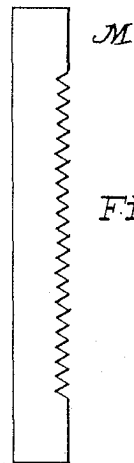
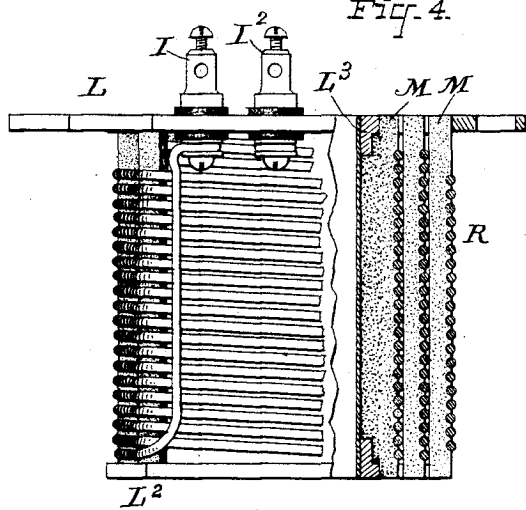


Fig. 5.

ATTEST:

*J. H. Hurdle*  
*Notary Public*

INVENTOR:

*Barton B Ward*

By *H. C. Townsend*  
Attorney

# UNITED STATES PATENT OFFICE.

BARTON B. WARD, OF NEW YORK, N. Y., ASSIGNOR TO THE ELECTRIC  
CONSTRUCTION AND SUPPLY COMPANY, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 444,473, dated January 13, 1891.

Application filed April 11, 1890. Serial No. 347,520. (No model.)

*To all whom it may concern:*

Be it known that I, BARTON B. WARD, a citizen of the Dominion of Canada, and a resident of New York, in the county of New York and State of New York, have invented a certain new and useful Electric-Arc Lamp, of which the following is a specification.

My invention relates to the manner of disposing the artificial resistance used in connection with electric-arc lamps, either in circuit with the carbons or in a shunt around them.

The object of my invention is to secure compactness, accessibility, and facility of handling the lamp, as well as to permit the electric resistance to be readily connected up to the lamp-circuits, either in series with the carbon or into the branch circuit of a cut-out device.

My invention relates, further, to the special construction of the resistance and its frame, with the purpose of adapting it to its peculiar location and manner of support and of securing thorough ventilation or exposure of the resistance-wire to cooling-currents of air.

My invention consists in the combination, with an electric-arc lamp, of a lamp-hood, a chimney for the arc lamp, and an artificial resistance-frame mounted in the chimney of the hood independently of the lamp and provided with a vertical passage or opening to receive the lamp-chimney.

My invention consists, further, in the combination, with an electric-arc lamp, of the lamp-hood provided with devices for sustaining an arc lamp within it, with the chimney of the lamp extending up within the chimney of the hood, and an electric resistance-frame mounted in the chimney for the hood and having its resistance-wire connected to terminal binding-posts accessible within the lamp-hood.

My invention consists, also, in constructing the frame from a suitable supporting cage or frame having radial slots in its opposite heads, within which are supported and retained insulating bars or rods extending from one head to the other, and superposed upon one another in the slots, such insulating bars or rods having the resistance-wire wound over them and between them, as will hereinafter appear.

My invention consists also in the special de-

tails of construction and combinations of parts, hereinafter more particularly described, and then specified in the claims.

In the accompanying drawings, Figure 1 is a side elevation of a lamp-hood and resistance-frame mounted in the hood and constructed in accordance with my invention, the parts being shown in vertical section. Fig. 2 illustrates a variation in the manner of connecting the resistance to the lamp-circuits. Fig. 3 is a plan of the resistance-frame inverted. Fig. 4 is a side elevation and partial vertical section of such frame. Fig. 5 represents one of the insulating bars or blocks over which the resistance-wire is wound.

A indicates a hood of any ordinary shape, adapted to protect an outdoor electric-arc lamp, and having the usual chimney B.

C indicates in outline the case of an electric-arc lamp, and D D hooks, which may also form electric terminals of the lamp and are adapted to suspend the lamp from hangers E E. These hangers may be in electrical connection with binding posts or blocks F F<sup>2</sup>, supported by the head of the hood but insulated therefrom as indicated. They may be held in place by means of bolts H, which pass up through the heads, and are provided with nuts G, that may have eyes or hooks for suspending the hood. The bolts H have bushings of insulating material, as indicated. The blocks or posts F F<sup>2</sup>, of conducting material, are properly connected with the line-wires W W. Block F may have one wire fastened directly to it while the other block F<sup>2</sup> may be connected by a short wire W<sup>2</sup>, the terminals of which are fastened, respectively, to block F<sup>2</sup> and to a third post or block F<sup>3</sup>, sustained in the head of the hood and having the other line-wire connected directly to it.

The carbons of the electric-arc lamp are indicated at P P<sup>2</sup>, while one of the lamp-magnets is indicated at P<sup>3</sup>, and in Fig. 1 a cut-out magnet is also indicated at P<sup>4</sup>. This cut-out magnet is placed in the circuit to the carbons and normally holds open a cut-out switch; but when the circuit is interrupted it releases its armature and closes the cut-out circuit.

R is an artificial electric resistance mounted on a suitable frame and sustained within the

chimney of the hood, as indicated. This resistance frame or support is provided with a vertical central passage adapted to receive the chimney K of the lamp when the lamp is sustained within the hood in the ordinary or any suitable manner. The means for sustaining such resistance-frame may be varied at pleasure. The particular devices for this purpose form no part of my invention.

The chimney D is provided at or near its top with a number of openings, as shown, through which the air heated by contact with the resistance-coils may escape. It will be seen that by this arrangement a circulation of cooling-currents of air is provided for up through the chimney and out of the top thereof, such current coming into contact with the resistance-wires, and thereby keeping their temperature down should it tend to become excessive.

The terminals of the electric-resistance wire are connected to binding-posts I<sup>1</sup>, sustained on the resistance-frame or some part independent of the lamp. In the arrangement of the apparatus shown one of such posts I<sup>2</sup> connects to the block F, while the other is connected by a flexible wire with a post on the lamp which connects with the cut-out circuit in the lamp. By this arrangement the resistance R will be in the cut-out circuit when the cut-out magnet P<sup>1</sup> lets its armature drop to make connection with the stop that is connected to the hook B and hanger E, sustained from the post or block F<sup>2</sup>. The armature-lever for P<sup>4</sup> being connected with the post that is joined to wire I, the cut-out circuit will be formed in obvious manner.

The construction of the resistance-frame whereby a suitable ventilation is provided and whereby the central passage is readily provided for the chimney K is shown more clearly in Figs. 3, 4, and 5.

The supporting-frame or carrier on which the resistance-wire *r* is wound is made as follows: L L<sup>2</sup> are heads of a supporting-frame connected by a central tube L<sup>3</sup>, joined to the heads in any proper manner. In the heads L L<sup>2</sup> are radial slots or openings adapted to receive bars M, which may be of any suitable width or thickness in a radial direction, and which are superposed upon one another in the slots, as indicated. These bars or blocks are of insulating material, such as porcelain, lava, asbestos, or other suitable material, and are provided at their outer edges with notches or guides adapted to receive the resistance-wire. The inner one of the bars in each slot is provided, as shown in Fig. 4, with rabbets adapted to engage with rabbets or shoulders formed on the heads, so that it cannot slip out of place endwise. In building up the resistance the several bars or rods nearest the center of the heads are put in place and wire is wound around and over the same in the grooves until the grooves are filled, after which another set of bars is put in place over the first and the winding con-

tinued, the operation being repeated a number of times corresponding to the number of bars employed, the thickness of the wire, and the distance desired between the several layers. It is best to have the heads cut away as much as possible, leaving, however, sufficient material in which the slots may be formed, since by this means the wire will be better exposed to ventilating-currents of air which may circulate upward freely through the same in the spaces between the arms or extensions in which the slots are formed. On the lower head the binding-posts I I<sup>2</sup> are mounted and properly insulated therefrom, as indicated.

To support the resistance-frame, I may provide the lower head with arms or extensions, as indicated in Fig. 3, in which bayonet slot-joints are formed adapted to engage with the pins *i* on the head of the hood. The hood and resistance-frame, with resistance-wire in place, are fastened together, as shown in Fig. 1, and connection with them is made when the lamp is put in place. Should it be desired to use the resistance as a shunt or branch resistance around the lamp controlled by a cut-out switch, the connections may be made as in Fig. 1. If, however, it is desired to place the resistance in circuit with the carbons of the lamp, as may be sometimes necessary, then the connections may be readily changed, as indicated in Fig. 2. In this case the connecting-wire between post F<sup>3</sup> and post F<sup>2</sup> is detached, so as to break connection from F<sup>3</sup> to F<sup>2</sup>. Post I<sup>2</sup> and post or block F are also disconnected and a wire is run from F<sup>3</sup> directly to I<sup>2</sup>. Another connection is run directly from post I of the resistance to the block F<sup>2</sup>, thus putting the resistance in the circuit with the carbons, as indicated in Fig. 2.

It will be obvious that by means of these connecting devices or similar connecting devices adapted to change the connections between the resistance, the lamp, and the line-blocks or binding-posts, the resistance might be put into circuit in other ways. When the lamp is removed, the resistance remains in place.

What I claim as my invention—

1. The combination, with an electric-arc lamp, of a lamp-hood, a chimney for the arc lamp, and an artificial resistance-frame mounted in the chimney of the hood independently of the lamp and provided with a vertical passage or opening to receive the lamp-chimney.

2. The combination, with an electric-arc lamp, of a hood therefor, a chimney for the arc lamp, binding-posts for connection with the line-wire, mounted in the head of the hood for such lamp, an electric resistance-frame secured within the chimney of the hood and having a vertical central passage or opening for the chimney of the lamp, and binding-posts or connecting devices, substantially as described, for permitting the connections

of the resistance with the lamp and line wires to be charged at pleasure.

3. The combination, with an electric-arc lamp, of the lamp-hood provided with devices  
5 for sustaining an arc lamp within it, with the chimney of the lamp extending up within the chimney of the hood and an electric resistance-frame mounted in the chimney for the hood and having its resistance-wire connected  
10 to terminal binding-posts  $II^2$ , accessible within the lamp-hood, as and for the purpose described.

4. In an electric resistance-frame, the combination, with the supporting-frame having  
15 the heads provided with radial slots, of insulating bars or rods seated in the slots and superposed upon one another and resistance-wire wound over said bars in layers between them.

20 5. In an electric resistance-frame, the combination, with the heads connected by a tube and provided with the radial slots, of insulating bars or rods mounted in the slots and provided with notches or grooves to receive  
25 the resistance-wire and with rabbets or offsets engaging with the heads, as and for the purpose described.

6. In an electric resistance-frame, bars or rods  $M$ , of insulating material, disposed at  
30 intervals around the circumference of such frame and provided with notches or grooves to receive the resistance-wire, said bars or rods being supported upon one another, as described, and holding the resistance-wire in  
35 place between them in the notches.

7. In an electric resistance-frame, the combination, with the heads  $L L^2$ , of the connecting-tube and the bars  $M$ , superposed upon one another in slots in the heads and having  
40 grooves or notches at their edges to hold the resistance-wire, as and for the purpose described.

8. The combination, with the hood for an electric-arc lamp, of a chimney for such hood  
45 rising above the same and provided at near its top with openings to allow the escape of heated air, and a resistance-frame mounted within the chimney below such openings, and provided with binding-posts mounted on the  
50 lower head of the frame at or near the bottom of the chimney and having their shanks connected, respectively, to the terminals of the resistance-coil.

9. The combination, with the resistance-frame having the connected heads and a central  
55 passage or bore, of a wire-supporting bar or rod provided with notches in its outer edge and with rabbets or shoulders at its inner edge to hold it against longitudinal displacement.  
60

Signed at New York, in the county of New York and State of New York, this 9th day of April, A. D. 1890.

BARTON B. WARD.

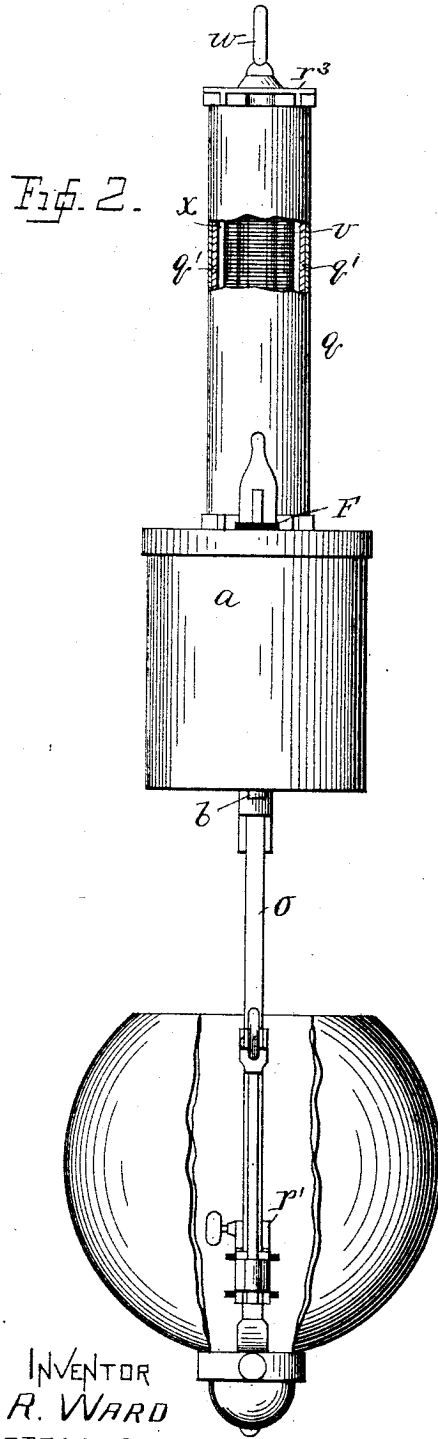
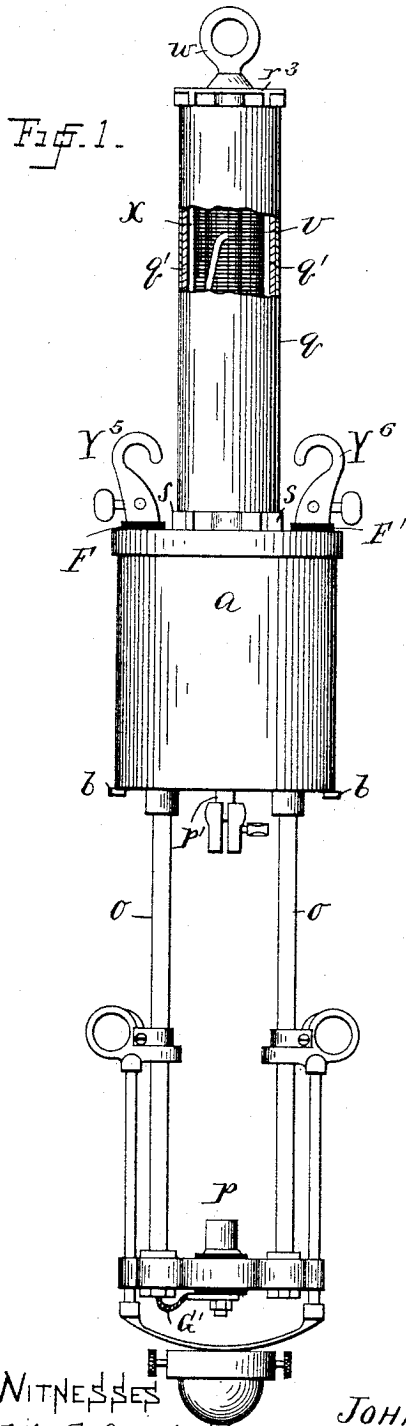
Witnesses:

WM. H. CAPEL,  
HUGO KOELKER.

J. H. R. WARD.  
ELECTRIC ARC LAMP.

No. 449,237.

Patented Mar. 31, 1891.



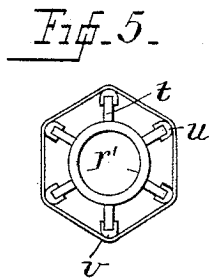
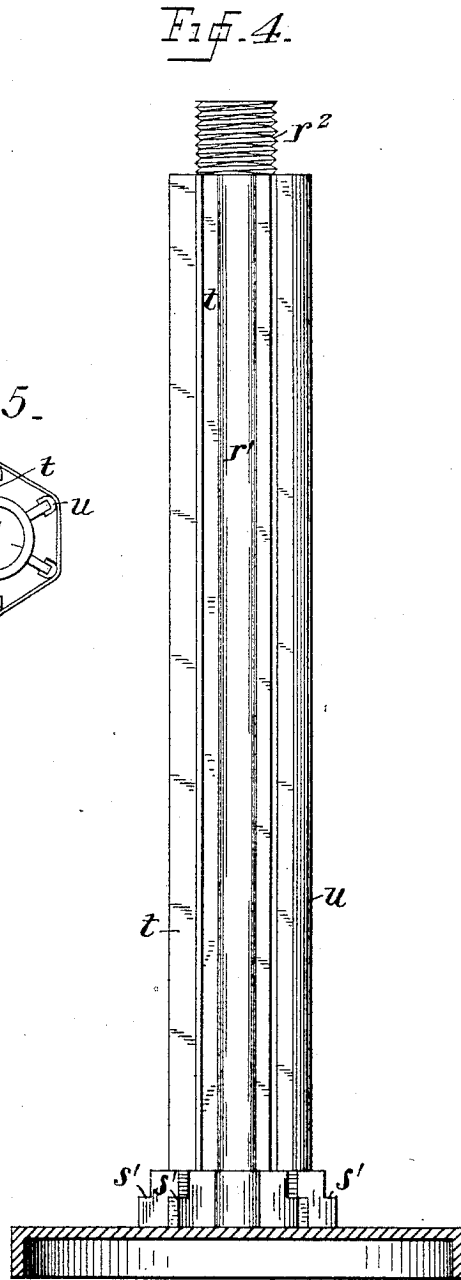
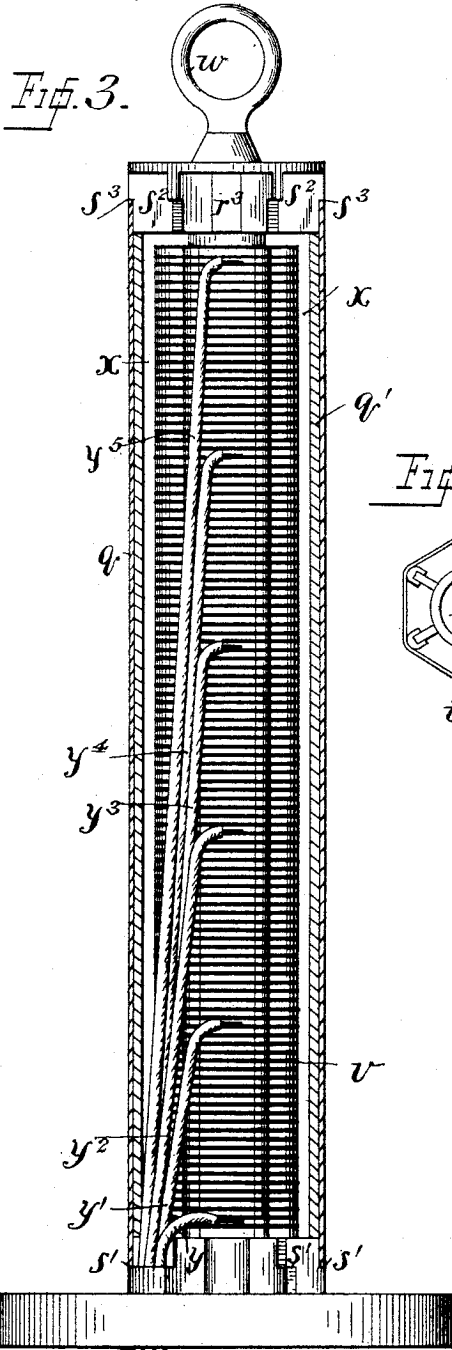
WITNESSES  
 Will A. Coutland  
 Nellie L. Pope.

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 BY HIS ATTORNEY  
 Edward P. Thompson

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*y^4 y^4 y^4 y^4 y^4 y^4*  
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 Nellie L. Pope

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 Edward P. Thompson



J. H. R. WARD.  
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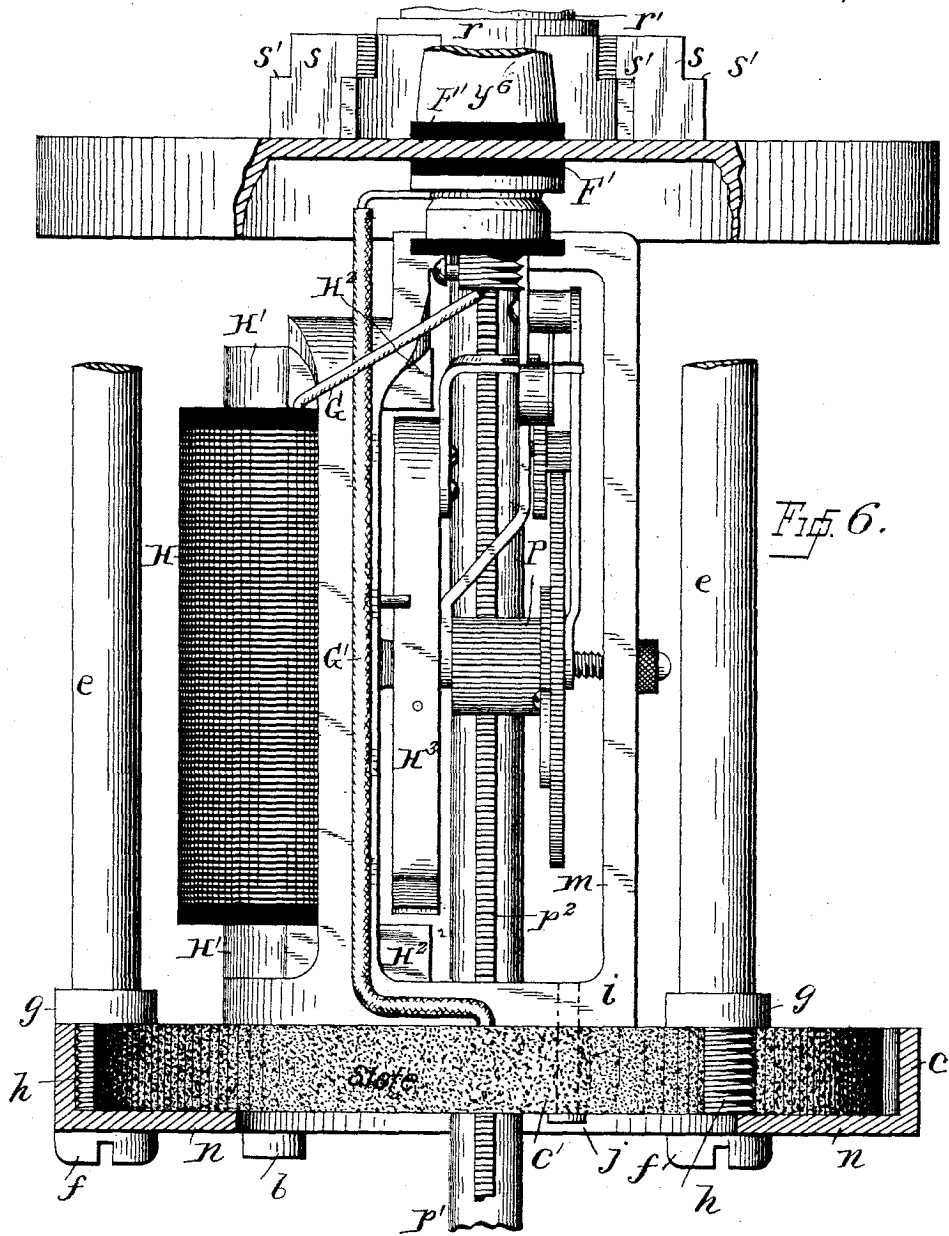


Fig. 6.

WITNESSES  
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BY HIS ATTORNEY

*Edward P. Thompson*

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No. 449,237.

Patented Mar. 31, 1891.

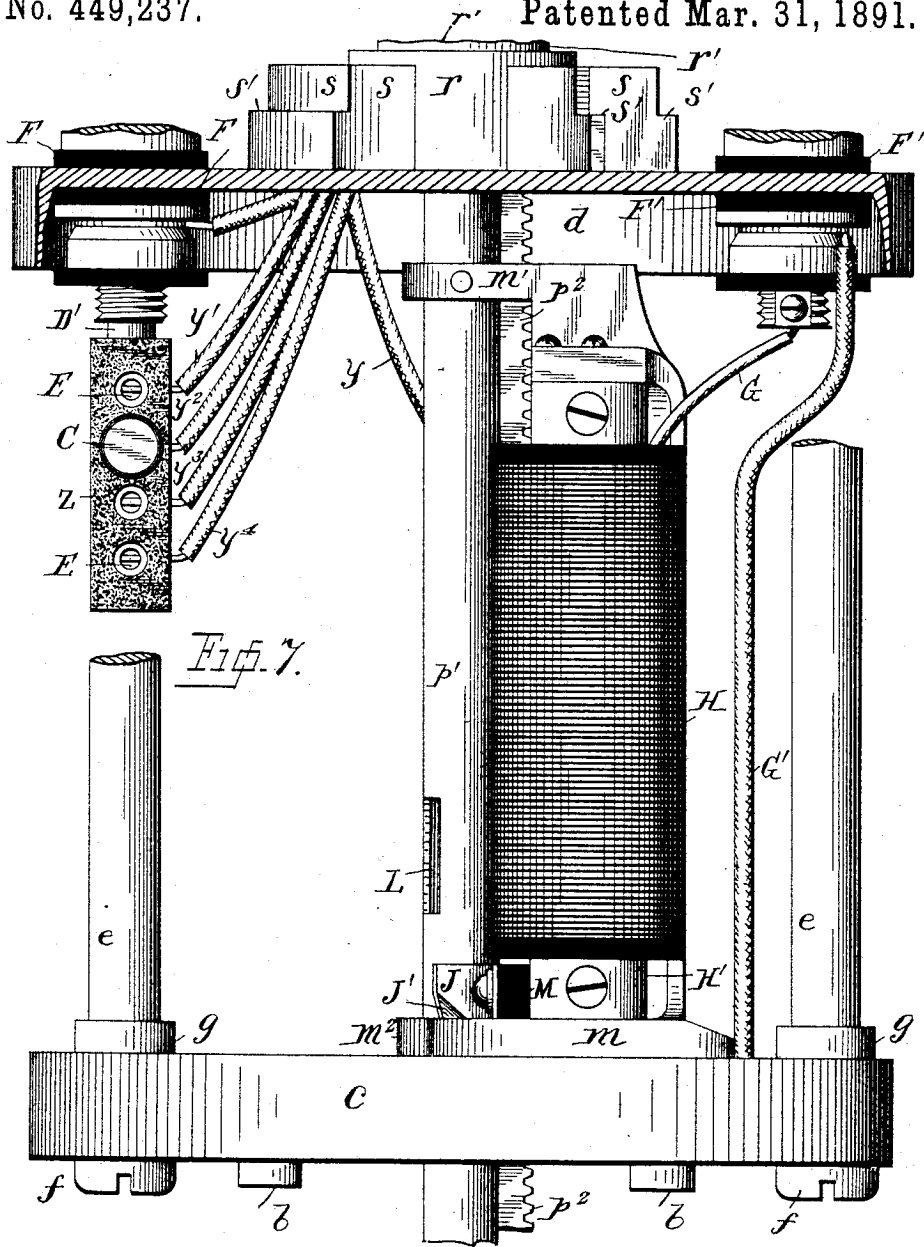


Fig. 7.

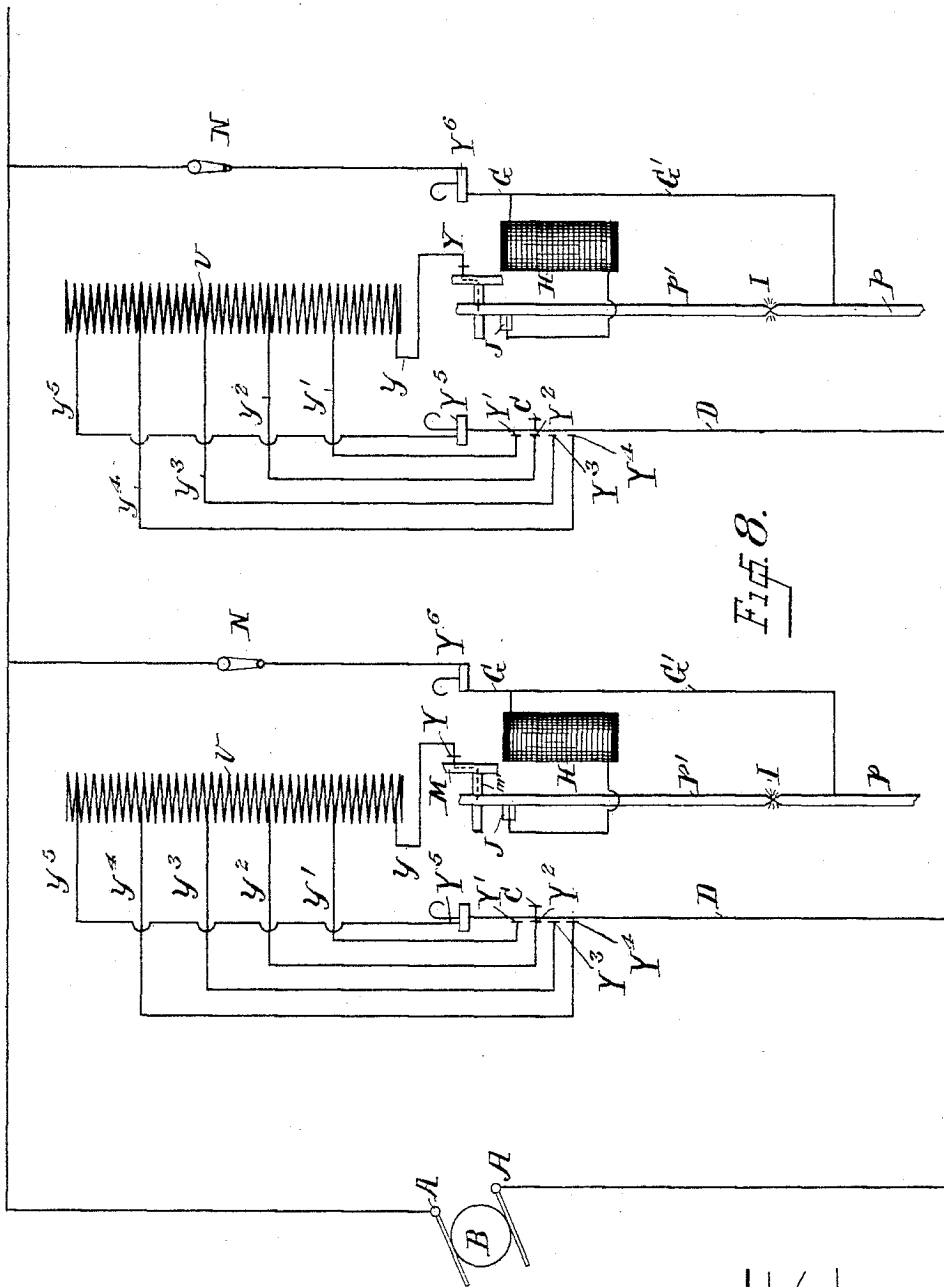
WITNESSES  
 Will H. Courtland  
 Nellie L. Pope.

INVENTOR  
 JOHN H. R. WARD  
 BY HIS ATTORNEY  
 Edward P. Thompson

J. H. R. WARD.  
ELECTRIC ARC LAMP.

No. 449,237.

Patented Mar. 31, 1891.



WITNESSES  
*Will H. Courtland*  
*Nellie L. Pope*

INVENTOR  
 JOHN H. R. WARD  
 BY HIS ATTORNEY

*Edward P. Thompson*

# UNITED STATES PATENT OFFICE.

JOHN H. R. WARD, OF NEW YORK, N. Y., ASSIGNOR TO THE UNIVERSAL  
ARC LAMP COMPANY, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 449,237, dated March 31, 1891.

Application filed December 8, 1890. Serial No. 373,943. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN H. R. WARD, a citizen of the United States, and a resident of New York, county and State of New York, have invented certain new and useful improvements in Electric-Arc-Lamp Regulators, (Case No. 5,) of which the following is a specification.

The present invention relates to the details of mechanical construction of that type of electric-arc lamp which is adapted for especial use with incandescent electric-lighting circuits or those circuits in which the current is of comparatively low electro-motive force.

The object of the invention is to provide simple and efficient means in connection with the lamp for ventilating the regulating-coils, for connecting up the coils according to the circuit in which it is included, and, in general, for supplying a lamp of improved principles of mechanical construction.

The invention involves numerous details, which are brought forth in the accompanying drawings, reproduced from a full-size working model, except that the dimensions of some of the parts are slightly different from corresponding parts in the model.

Figures 1 and 2 are vertical elevations, taken at right angles to each other, of the exterior of a complete lamp on a small scale, a portion of the chimney being broken away in both figures and a portion of the globe being removed in Fig. 2. My invention relates particularly to the upper part of the lamp shown in Figs. 1 and 2. Fig. 3 is an enlarged view of the chimney of the lamp, partially in section. Fig. 4 is an exterior elevation of that portion of the chimney for holding the regulating-coil. Fig. 5 is a plan view of Fig. 3, assuming that the upper part or top of the chimney is omitted. Fig. 6 is an interior view of the central portion of Figs. 1 and 2. The view is taken in the same direction as that of Fig. 2. A portion of the front casting is broken away, as indicated by the section lines. The lower part or casting, forming the base-plate for the mechanism and magnet and frame for holding the mechanism, is shown in section, while the pillars or rods connecting the upper

and lower castings are partly omitted at the top; but in practice they extend to the upper casting and are secured thereto. Fig. 6 illustrates that the type of lamp is that involving not a frictional clutch, but a rack-gearing on the carbon-holder engaging with a pinion operated by mechanism which is controlled by an armature of a magnet. As the particular kind of mechanism has nothing to do with the present invention, the same is omitted in all figures except Fig. 6. The magnet is provided with pole-pieces extending to the right, and the armature reaches from one pole-piece to the other, sufficient space being left whereby the armature may oscillate upon an axis perpendicular to that of the magnet and coinciding with that of the pinion. The armature has a projection at its upper end bent over to the right, which by an oscillating motion now and then operates the mechanism according to the amount of current passing through the magnet. This mechanism forms the subject-matter of another application. Fig. 5 is a vertical elevation of the interior of the middle portion of the lamp, the same as in Fig. 6, except that the view is at right angles to that in Fig. 6, except that the mechanism is almost entirely omitted, except that the parts in section in Fig. 6 are not all in section in Fig. 7, and except that the portions broken away for the sake of clearness are not exactly the same in both figures. The upper portions of the figures are identical with the lower portions of Figs. 3 and 4. Fig. 8 shows, partly in diagram, the electrical circuits and connections throughout the lamp from one pole to the other, and it shows two such lamp-circuits connected in parallel; but in practice it is usually preferable to put them in parallel in pairs.

The letters of reference in Fig. 6 identify corresponding parts in one or more of the preceding figures.

*a* represents a cylindrical casing for surrounding the inclosed mechanism, electric contacts, magnets, &c. It is supported upon rotary catches or projections *b*, suspended from the lower plate or casting *c*, hereinafter described. When these are turned part way

around, the casing *a* will drop. The upper end of the casing extends into the upper casting *d*.

*c* represents an external view of the base-plate for the mechanism frame, magnet, and upper plate or casting *d*.

*c'* is a disk of insulation located within the casting *c*, which is cylindrically hollow. It is made preferably of some kind of stone—as, for instance, slate. It is provided with a circular hole, through which passes a carbon-holder with such other holes as may be necessary for the passage of wires and with arc-shaped grooves for the passage of the rods or pillars *e*, which are three in number, and which are attached to the casting *c* by means of screws *f*, which pass into the ends of the pillars *e*. The rings *g* are screwed down tight against both the casting *c* and the insulation *c'*, the screw-threads *h* extending into the rings *g*. One or more screws *i*, having heads *j*, secure the frame *m* to the insulating-plate *c'*. The central hole in the casting *c* is so large as to leave merely a supporting-flange *n*, which helps to uphold the disk *c'* of insulating material. The disk *c'* is dotted in order to indicate arbitrarily that it is made of insulating material. The function of the disk *c'* is to insulate the frame *m* and everything attached thereto from the casting *c*, which is necessarily electrically connected to the rods *o*, and hence to the lower-carbon holder *p*. The pillars *e* are tubular at and near both ends, so that the lower screws *f* and the upper screws *f'* may be screwed into said rods or pillars, and thereby secure the casting *b* to the casting *c*.

*d* represents the upper casting, which is supported upon the pillar *e*, and which in turn supports the element *q*, which is the chimney of the lamp. The casting *d* consists of an inverted hollow cylindrical piece provided with a peculiarly-shaped ventilating-support for the chimney. This support consists of a tube *r*, provided with ribs or extensions *s*, radiating from the outer surface of said tube, said ribs being in the shape of steps, the step being represented by *s'*. Upon these steps, there being one step for each rib, rests the chimney *q*. Through the spaces between the ribs and below the steps *s'* may pass air for ventilation. A similar construction is provided at the upper end of the chimney.

Into the tube *r* screws a smaller tube *r'*, also provided with ribs or linear projections, which are lettered *t*. There are six ribs provided. Arc-shaped strips of insulation of fire-proof material, such as asbestos *u*, extend along and near the outer edges of said ribs. A subdivided coil of wire of high resistance, such as a German-silver coil *v*, is wound upon the asbestos. The ribs and asbestos serve to hold the wire coil at the proper distance from the tube *r'*, while the asbestos itself forms a good fire-proof insulation from the metal ribs *t*. The asbestos also forms a convenient bad

conductor of heat. On the upper end of the tube *r'* is provided an external screw-thread *r''*, which carries a cap *r'''*, provided with ribs *s''*.

*s'''* represents steps corresponding to *s'*. Against these steps presses the upper end of the chimney *q*, so that the cool air which enters at the lower end of the chimney passes out at the upper end between the ribs *s''*. The interior of the chimney is lined with a comparative heavy thickness of asbestos *q'*. This asbestos being a poor conductor of heat compared with metal prevents considerably less heat being conducted away to the magnet of the lamp than if it were not present. At the same time it is fire-proof substantially.

The ring *w* forms a part of the same casting with the cap *r'''*. This is the usual ring employed for suspending the lamp.

Between the coil *v* and the asbestos lining *q'* is a cylindrical tubular space *x* for a passage of some of the air passing through the cylinder.

*y y' y'' y''' y'''' y'''''* are copper conductors connecting the terminals of the several sections of the subdivided coil *v* (see Fig. 3) to the respective terminals of the various electrical devices or parts of the lamp. The wire or conductor *y* connects with the frame *m* at the binding-post Y. The conductor *y'* connects with the uppermost binding-post Y', which is mounted upon the block *z* of insulating material. Binding-posts Y'' Y''' Y'''' are provided upon the block *z*, are insulated from each other, and are respectively connected permanently with the conductors *y'' y''' y''''*. The conductor *y'''''* is connected to one of the terminals Y''''' of the lamp, the other terminal being indicated by Y'''''. The terminals Y'''''' and Y''''''' are connected to the poles A respectively of the generator B. A screw-plug C is adapted to pass through one or the other openings made in the conductor D, and to press against any one of the binding-posts Y' Y'', &c. The conductor D is enlarged, as indicated in the lamp by D', which passes through the entire length of the block *z*. When the screw-plug C enters holes E in said enlarged portion D', it presses against one or the other of the binding-posts Y' Y'', &c., so that, according to the hole in which the screw plug is introduced one or more of the sections of the subdivided coil *v* will be included in circuit with the carbon-holders. The enlarged portion D' forms a projection to the terminal Y''''', which is properly insulated by washers F from the casting *d*. Similar washers F' insulate the terminal Y'''''' from the casting *d*. The binding-post Y'''''' connects by the conductor G with the magnet H. The same terminal is connected by the conductor G' with the lower-carbon holder *p*. The conductor G' passes through one of the tubes *o*, (see Fig. 1.) where it issues from said tube and connects with said carbon-holder. The frame *m* has a projection *m'*, provided

with a hole, through which passes the upper-carbon holder  $p'$ . The current through the conductor  $y$  connects with the binding-post Y, which is connected to the frame  $m$ . From  
 5 thence it passes to the projection  $m'$  to the upper-carbon holder  $p'$ , thence through the arc I to the lower carbon-holder  $p$ , thence through the conductor G', then branching it enters both the binding-post Y'''''' and the  
 10 magnet H to a brush J, which bears against the upper-carbon holder  $p'$ . This holder is provided with a hole L, so that when the carbon has fallen or has been fed to approximately its lowest position the brush J ceases  
 15 contact with the holder, which is in the form of a tube. In order to effect this cutting out, the brush J is bent outward, as indicated by the bent portion J'. The brush is attached to insulation M, which is mounted upon the  
 20 pole-piece H' of the magnet H. It is found in practice to be much more effectual to have the hole L than to have the same filled with insulating material, which is likely to become burned at the edges by sparking or to become  
 25 warped by atmospheric changes or to become covered with particles of dust which serve gradually to disintegrate the insulation. The brush J is of such a tension and of such a length that when it arrives opposite the hole  
 30 L it will not be in contact with the holder  $p'$ , so that when the carbon-holder is in its lowest position the magnet H will be cut out of circuit. At any time desirable the carbon-holders  $p$  and  $p'$  may be cut out of circuit by circuit-controllers N.

It was stated above that electrical contact from the frame  $m$  to the carbon-holder  $c'$  was made at the projection  $m'$ . It is also formed at the projection  $m''$ , through which is a hole  
 40 for the passage of the carbon-holder  $c'$ . The holes in the projections  $m'$  and  $m''$  are as nearly as possible equal to the diameter of the carbon-holder  $c'$ , while the surfaces of all three elements are bright, so that the electrical contact is certain. The poles H' of the magnet have horizontal polar projections H'', which project over the extremities of the armature H'''.

When the lamp is included in a circuit carrying a current of high electro-motive force as compared with another current carrying a lower electro-motive force, the lamp may be adapted for each current by varying the number of seconds of the coil  $v$  in direct circuit.  
 55 The whole of said coil is always in circuit; but when the screw-plug C is put in contact with the binding-post Y''''''', for instance, the uppermost section of the coil becomes a shunt to the other coils, so that the resistance of the lamp becomes less than when the screw-plug C is removed. The resistance may be further decreased by placing said screw-plug successively in contact with the binding-posts Y''' Y'' Y'. It may be noticed that the  
 65 magnet H, which is carried by the frame  $m$ , is not only electrically insulated, but is also insulated as to heat from the coil  $b$ , which on

account of its comparatively high resistance becomes very hot. The slate disk  $c'$  is practically, on account of its mass, a non-conductor  
 70 of heat, while the air-space between the upper part of the frame  $m$  and the casting  $d$  is also practically a non-conductor of heat. Further, the disk  $c'$  is well ventilated, so that it will not collect very much heat. The result is that the magnet H does not rise to a  
 75 very high temperature. At least its temperature is much lower than is generally attained by other lamps of this class, in so far as my experience is concerned. The ventilation  
 80 through the lamp-chimney is also a means of maintaining the temperature of the magnet H as low as possible.

The object in maintaining or obtaining a small increase of temperature of the magnet  
 85 H over the ordinary atmospheric temperature may be stated as follows: As the resistance increases with the heat, the resistance of the wire of the magnet H gradually increases, so that a considerable of time passes before the  
 90 lamp reaches its normal condition. By the mechanical construction of the lamp this interval of time is considerably shortened.

The carbon-holder  $p'$  is provided along its length with a rack  $p''$ , which is engaged with  
 95 a pinion P, mounted upon the same shaft with the armature H'''. By the combined actions of the force of the armature, gravitation, or springs, the feed of the carbon-holder  $p'$  is regulated. The details of this mechanism do  
 100 not form the subject-matter of the present invention, and are not therefore described fully.

There are certain other details as to shape, proportions, means for connecting parts together, and for making them detachable that  
 105 are not described, as they do not form the subject-matter of the present invention.

I claim as my invention—

1. In an electric-arc lamp, the combination  
 110 of a casting  $d$ , forming a cover to the mechanism of the lamp, provided with a tubular projection  $r$ , upon which are radial projections or ribs  $s$ , provided with steps  $s'$ , the said elements  $r$ ,  $s$ , and  $s'$  forming an integral  
 115 part with the casting  $d$ , a vertical tube  $r'$ , having its lower end screwed into the tube  $r$  and provided with longitudinal ribs  $t$  at substantially equal distances from each other, fire-proof strips  $u$ , of insulating material, extending along the outer edges of the ribs  $t$ , a coil of  
 120 wire  $v$ , of German silver or of similar material having a high resistance, wound upon said strips  $u$  and around the tube  $r'$  and divided into sections whose terminals are  $y$   $y'$   $y''$ , &c.,  
 125 means, such as a screw-plug C, for connecting one or more of the sections of the coil in circuit with the carbon-holders  $p'$  and  $p$  of the said lamp, a tubular cap  $r$ , screwed upon the upper end of the tube  $r'$  and provided with  
 130 radial ribs  $s''$ , having steps  $s'''$ , and a cylindrical casing  $g$ , provided with an interior lining of a heat-insulating substance of fire-proof material, the said casing having its ends

pressing, respectively, upon the steps *s'* and *s'''*.

2. In an electric-arc lamp, the combination of a base-plate or casting *c*, containing a disk of heat-insulating material, such as slate *c'*, whose interior diameter is less than the interior diameter of the casting *c*, a frame *m*, carrying the lamp mechanism, and lamp-magnet mounted upon and secured to said disk for the purpose, as described, of insulating the magnet *H* of the lamp as to heat from all metal portions of the lamp except the frame *m*, pillars *e*, having external and internal screw-threads upon their lower ends and internal screw-threads upon their upper ends, screws *f*, passing through the casting *c* into the lower ends of said pillars, screw-rings *g*, located upon the said external screw-threads and pressing upon both said disks and said cast-

ing, and an upper casting *d*, supported upon said pillars and secured thereto by screws *f''*, passing through said cover and into the upper ends of said pillars, and a cylindrical casing *a*, whose upper end fits within said casting *d*, and whose lower end surrounds the lower casting *c*, means, such as rotary projections or buttons *b*, being provided on the lower part of said casting *c* for the purpose, as described, of supporting said casing *a*.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 1st day of May, 1890.

JOHN H. R. WARD.

Witnesses:

EDWARD P. THOMPSON,  
E. G. DUVALL, JR.

J. H. R. WARD.  
ELECTRIC ARC LAMP.

No. 449,238.

Patented Mar. 31, 1891.

Fig. 1.

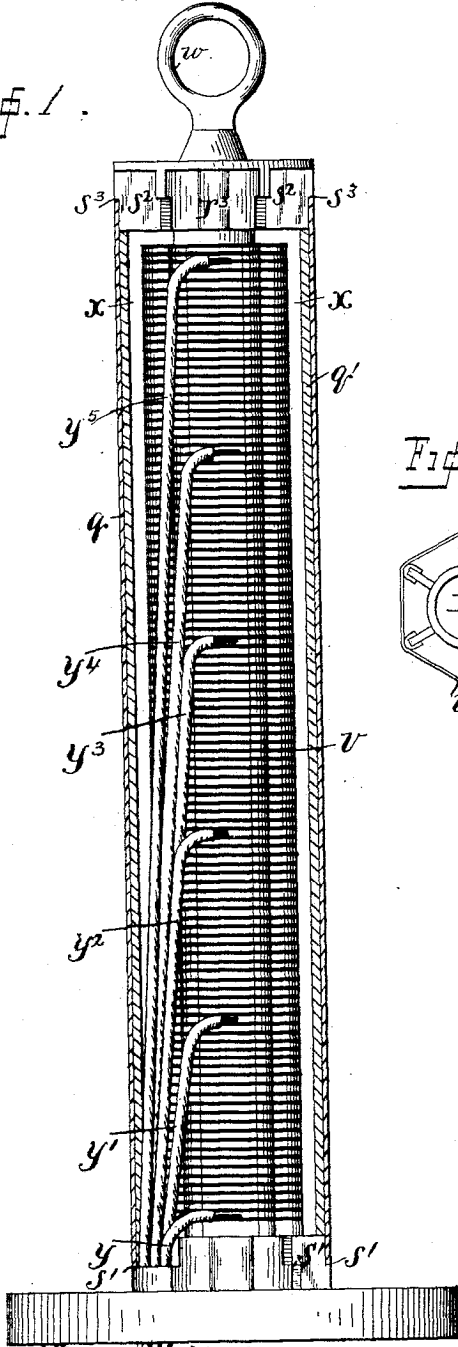


Fig. 3.

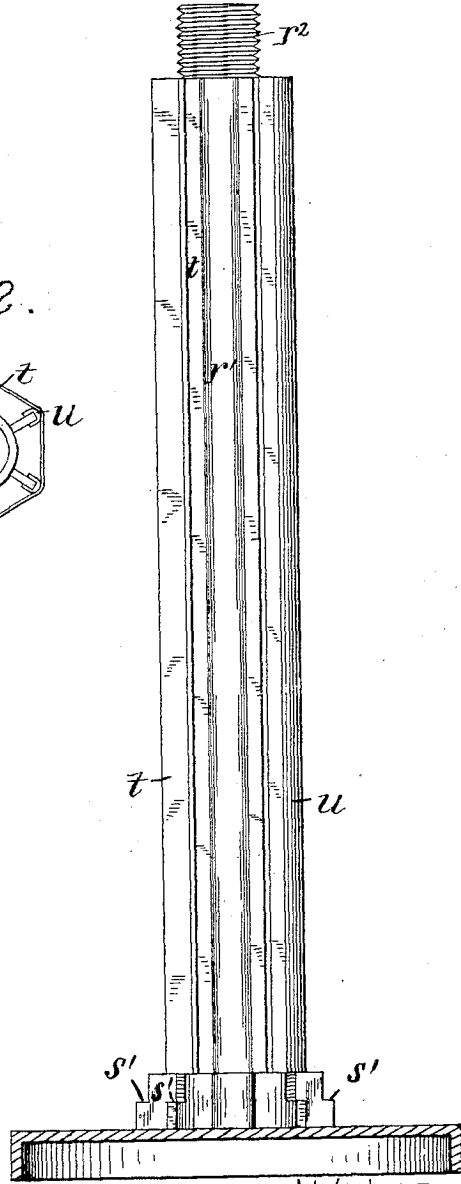
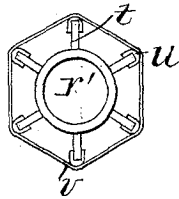


Fig. 2.



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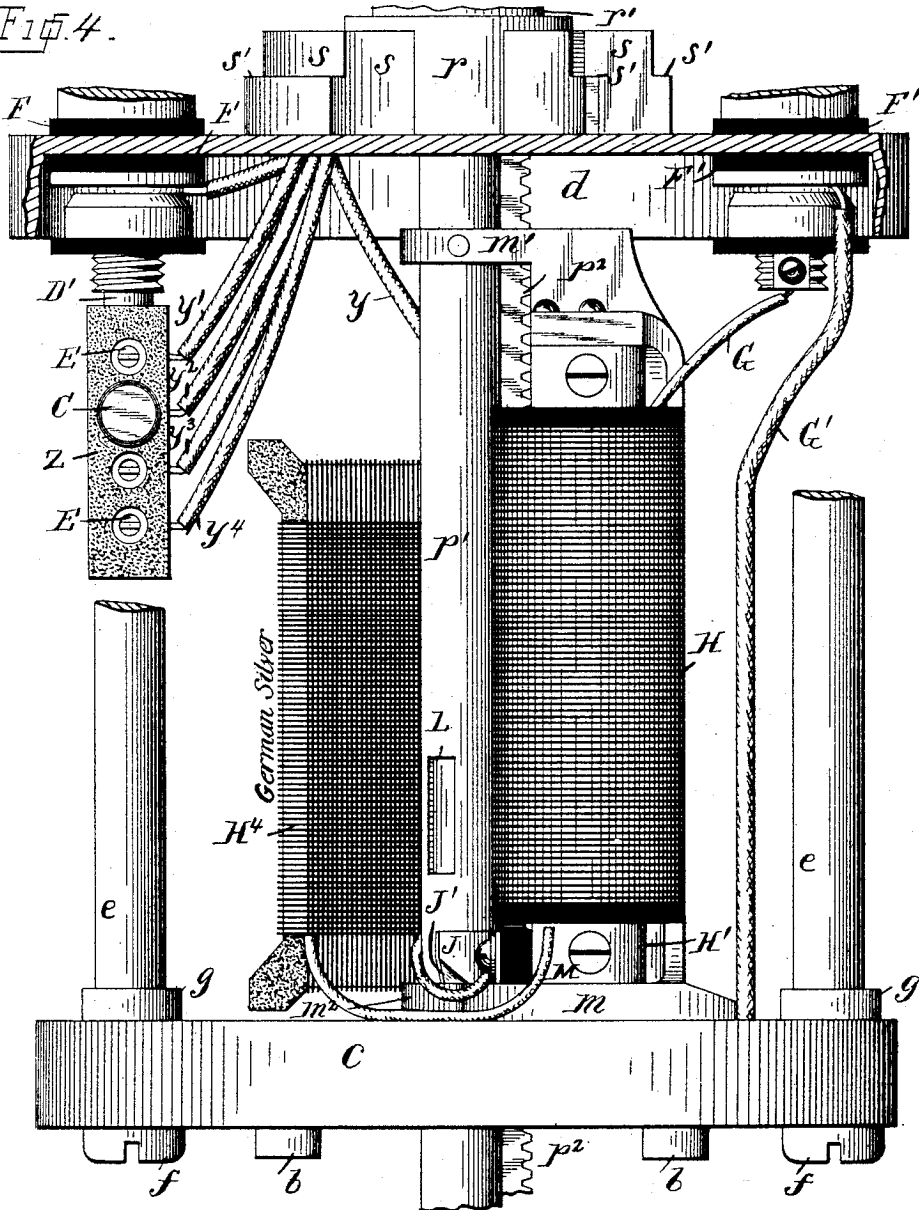


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Fig. 4.



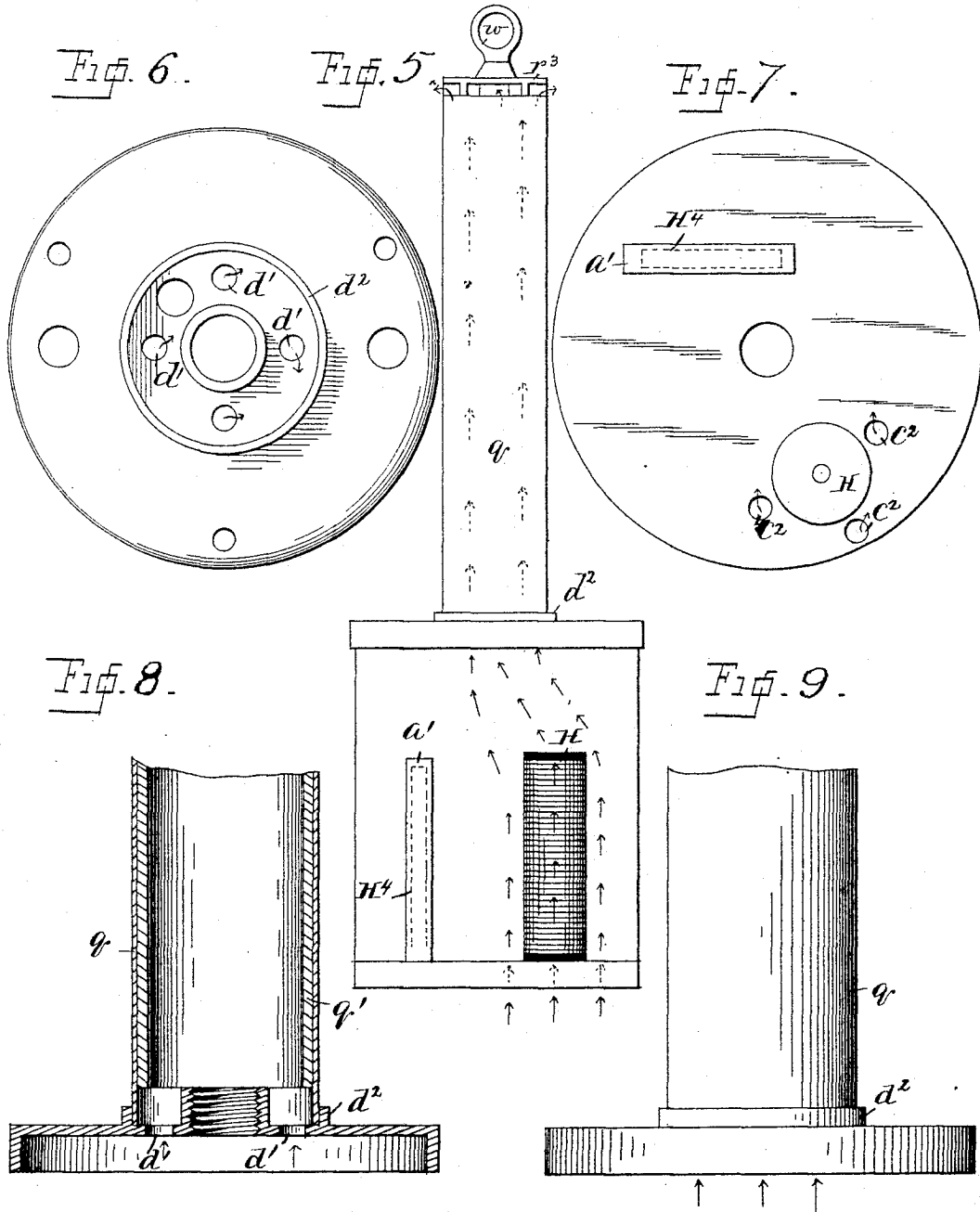
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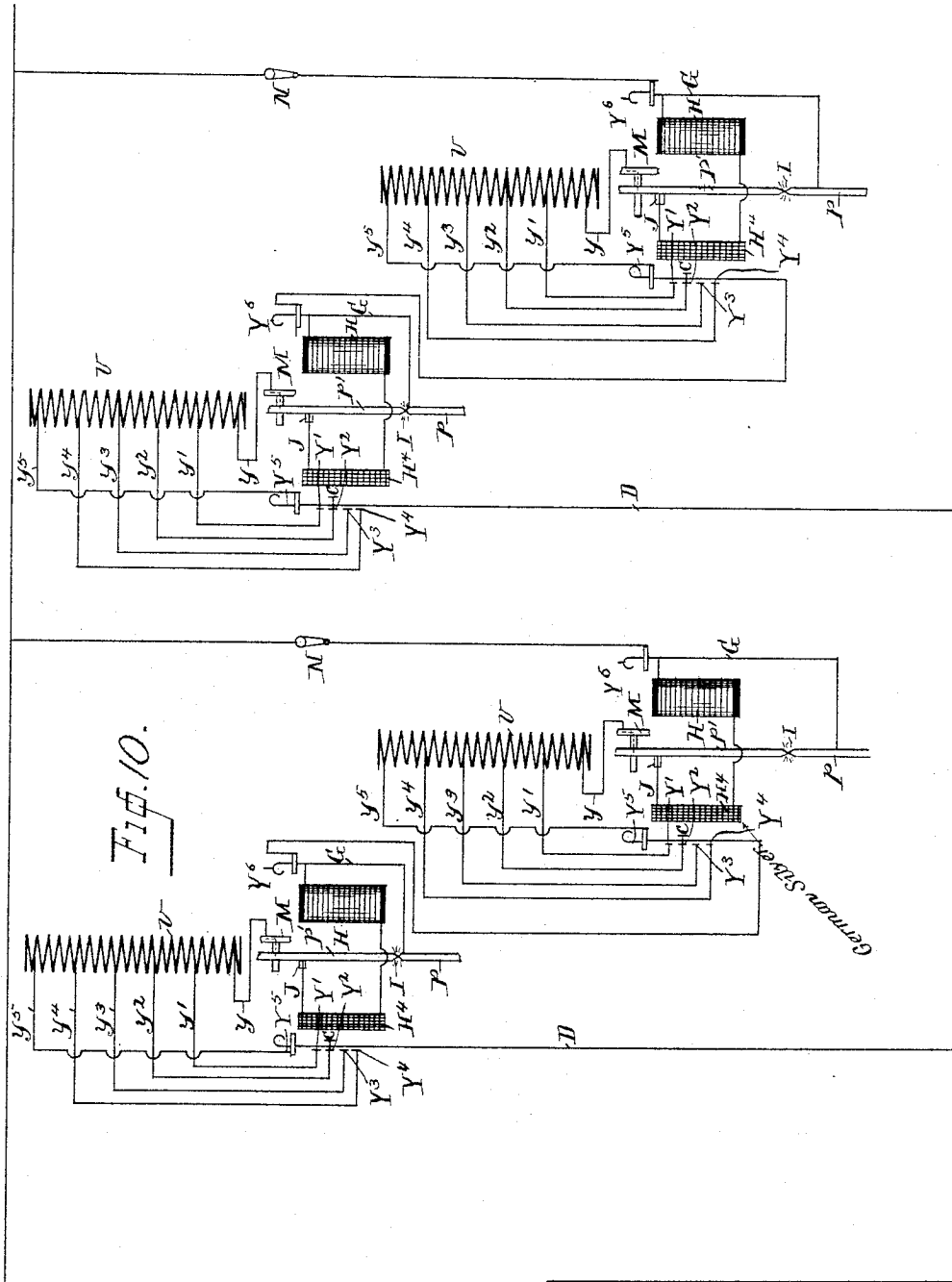
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# UNITED STATES PATENT OFFICE.

JOHN H. R. WARD, OF NEW YORK, N. Y., ASSIGNOR TO THE UNIVERSAL  
ARC LAMP COMPANY, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 449,238, dated March 31, 1891.

Application filed December 11, 1890. Serial No. 374,344. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. R. WARD, a citizen of the United States, and a resident of New York, county and State of New York, have invented certain new and useful Improvements in Electric-Arc-Lamp Compensators, (Case No. 1,) of which the following is a specification.

The invention relates to means for maintaining the arc of the lamp at substantially uniform intensity, especially during the first few minutes or half hour after the lamp has been switched into circuit. The type of lamp to which my invention is especially applicable is that which is used with currents of comparatively low electro-motive force. In these lamps it is usual to employ a resistance-coil in the chimney of the lamp, and as said coil becomes hot the metal portions of the lamp gradually conduct the heat to the operating-magnet or solenoid of the lamp. Consequently the resistance of the wire of the magnet or solenoid gradually and slowly increases and does not reach a constant maximum resistance until several minutes after the lamp has been started to burn. A corresponding variation of the light ensues. To overcome this difficulty, I construct a lamp as set forth in every detail in the accompanying drawings.

Figure 1 is a vertical section of the chimney of the lamp, showing the resistance-coil divided into sections. This is the coil referred to afterward as that which causes the whole lamp to become heated. Fig. 2 is a plan view of Fig. 1, with the upper cap removed. Fig. 3 is a vertical elevation of the ribbed tube upon which the resistance-coil is wound. It is not clearly visible in Fig. 1. Its ribs are provided with a heat-insulator to prevent as much as possible any heat from being conducted from the coil to the tube, and hence to the operating-magnet of the lamp. Fig. 4 is a front elevation of a portion of a lamp equipped with my invention, showing the mechanical construction as used in practice. The magnet and German-silver coil are both visible. In these figures the connecting-conductors to different portions of the lamp are shown. Fig. 5 is a diagram view of a modification of the invention whereby the arc be-

comes adjusted quicker after the lamp is turned on. Figs. 6 and 7 are views of details of Fig. 5, the former being the base-plate of the chimney and the latter the base-plate of the operating-magnet. The German-silver coil is shown dotted. Figs. 8 and 9 are respectively sectional and outside views of the lower portion of the chimney. Fig. 10 shows in diagram the electrical distribution system and electrical connections in the lamp. Lamps are connected in pairs in parallel, and the intensity of the light is regulated by the coil in the chimney.

*d* represents the upper casting, which is supported upon the pillar *e*, and which in turn supports the element *g*, which is the chimney of the lamp. The casting *d* consists of an inverted hollow cylindrical piece provided with a peculiarly-shaped ventilating-support for the chimney. This support consists of a tube *r*, provided with ribs or extensions *s*, radiating from the outer surface of said tube, said ribs being in the shape of steps, the step being represented by *s'*. Upon these steps (there being one step for each rib) rests the chimney *g*. Through the spaces between the ribs and below the steps *s'* may pass air for ventilation. A similar construction is provided at the upper end of the chimney.

Into the tube *r* screws a smaller tube *r'* also provided with ribs or linear projections, which are lettered *t*. There are six ribs provided. Arc-shaped strips of insulation of fire-proof material—such as asbestos *u*—extend along and near the outer edges of said ribs. A subdivided coil of wire of high resistance—such as a German-silver coil *v*—is wound upon the asbestos. The ribs and asbestos serve to hold the wire coil at the proper distance from the tube *r'*, while the asbestos itself forms a good fire-proof insulation from the metal ribs *t*. The asbestos also forms a convenient bad conductor of heat. On the upper end of the tube *r'* is provided an external screw-thread *r<sup>2</sup>*, which carries a cap *r<sup>3</sup>*, provided with ribs *s<sup>2</sup>*. *s<sup>3</sup>* represents steps corresponding to *s'*. Against these steps presses the upper end of the chimney *g*, so that the cool air which enters at the lower end of the chimney passes out at the upper end between the ribs *s<sup>2</sup>*. The

interior of the chimney is lined with a comparatively heavy thickness of asbestos  $q'$ . This asbestos, being a poor conductor of heat compared with metal, prevents considerably less heat being conducted away to the magnet of the lamp than if it were not present. At the same time it is fire-proof substantially. The ring  $w$  forms a part of the same casting with the cap  $r^2$ . This is the usual ring employed for suspending the lamp. Between the coil  $v$  and the asbestos lining  $q'$  is a cylindrical tubular space  $x$  for a passage of some of the air passing through the cylinder.

$y$   $y'$   $y^2$   $y^3$   $y^4$   $y^5$  are copper conductors connecting the terminals of the several sections of the subdivided coil  $v$  (see Fig. 2) to the respective terminals of the various electrical devices or parts of the lamp. The wire or conductor  $y$  connects with the binding-post Y. The conductor  $y'$  connects with the uppermost binding-post Y'. Binding-posts Y<sup>2</sup> Y<sup>3</sup> Y<sup>4</sup> (see Fig. 9) are provided and are insulated from each other, and are respectively connected permanently with the conductors  $x^2$   $y^3$   $y^4$ . The conductor  $y^5$  is connected to one of the terminals Y<sup>5</sup> of the lamp, the other terminal being indicated by Y<sup>6</sup>. The terminals Y<sup>6</sup> and Y<sup>3</sup> are connected to the poles A, respectively, of the generator B. A screw-plug C is adapted to pass through one or the other openings made in the conductor D and to press against any one of the binding-posts Y' Y<sup>2</sup>, &c. The conductor D is enlarged, as indicated in the lamp by D', which passes through the entire length of the block  $z$ . When the screw-plug C enters holes E in said enlarged portion D', it presses against one or the other of the binding-posts Y' Y<sup>2</sup>, &c., so that according to the hole in which the screw-plug is introduced one or more of the sections of the subdivided coil  $v$  will be included in circuit with the carbon-holders. The enlarged portion D' forms a projection to the terminal Y<sup>3</sup>, which is properly insulated by washers F from the casting  $d$ . Similar washers P' insulate the terminal Y<sup>6</sup> from the casting  $d$ . The binding-post Y<sup>6</sup> connects by the conductor G with the magnet H. The same terminal is connected by the conductor G' with the lower-carbon holder  $p$ . The frame  $m$  has a projection  $m'$ , provided with a hole through which passes the upper-carbon holder  $p'$ . In this circuit is included also the German-silver coil H<sup>4</sup>. This holder is provided with a hole L, so that when the carbon has fallen or has been fed to approximately its lowest position the brush J ceases contact with the holder, which is in the form of a tube. In order to effect this cutting out, the brush J is bent outward, as indicated by the bent portion J'. The brush J is attached to insulation M, which is mounted upon the pole-piece H' of the magnet H. It is found in practice to be much more effectual to have the hole L than to have the same filled with insulating material, which is likely to become burned at the edges by sparking or to become warped

by atmospheric changes, or to become covered with particles of dust, which serve gradually to disintegrate the insulation. The brush J is of such a tension and of such a length that when it arrives opposite the hole L it will not be in contact with the holder  $p'$ , so that when the carbon-holder is in its lowest position the magnet H will be cut out of circuit. At any time desirable the carbon-holders  $p$  and  $p'$  may be cut out of circuit by circuit-controllers N. (See Fig. 9.)

It was stated above that electrical contact from the frame  $m$  to the carbon-holder  $c'$  was made at the projection  $m'$ . It is also formed at the projection  $m^2$ , through which is a hole for the passage of the carbon-holder  $p'$ . The holes in the projections  $m'$  and  $m^2$  are as nearly as possible equal to the diameter of the carbon-holder  $p'$ , while the surfaces of all three elements are bright, so that the electrical contact is certain.

When the lamp is included in a circuit carrying a current of high electro-motive force as compared with another current carrying a lower electro-motive force, the lamp may be adapted to each current by varying the number of sections of the coil  $v$  in direct circuit. The whole of said coil is always in circuit; but when the screw-plug C is put in contact with the binding-post Y<sup>2</sup>, for instance, the uppermost section of the coil becomes a shunt to the other coils, so that the resistance of the lamp becomes less than when the screw-plug C is removed. The resistance may be further decreased by placing said screw-plug successively in contact with the binding-posts Y<sup>3</sup> Y<sup>2</sup> Y'.

The ventilation through the lamp-chimney is a means of maintaining the temperature of the magnet H as low as possible. The object in maintaining or obtaining a small increase of temperature of the magnet H over the ordinary atmospheric temperature may be stated as follows: As the resistance increases with the heat, the resistance of the wire of the magnet H gradually increases, so that a considerable length of time passes before the lamp reaches its normal condition. By the mechanical construction of the lamp this interval of time is considerably shortened.

Attention is particularly called to the high-resistance coil H<sup>4</sup>, permanently in circuit with the magnet H. The coil H<sup>4</sup> is of such diameter and length that the current of the lamp heats it, and thereby causes its resistance to increase. Consequently the resistance of the circuit of the magnet H increases almost immediately after the current begins to pass through the lamp. Without this German-silver coil the resistance of said circuit would increase only slowly, and therefore the lamp would correspondingly slowly reach the normal candle-power. It is true that the German-silver coil is not an absolute compensator; but when its resistance is about two-thirds that of the magnet H it so fully compensates that the lamp is practically of

a given uniform candle-power within a few seconds after the current is turned on.

In Figs. 4, 5, 6, 7, and 8 is another modification. The degree of compensation of the coil  $H^4$  is greatly increased and more perfect. The base-plate  $c$  is provided with holes  $c^2$  around the lower part of the magnet  $H$ , and the upper plate  $d$  is likewise provided with holes  $d'$  in place of the radial projections  $s$ . A circular rim or projection  $d^2$  surrounds the holes  $d'$ , so that the chimney-casing  $q$  will fit therein and prevent water from entering the holes  $d'$ . The coil  $H^4$  is inclosed entirely by a box or casing  $a'$ , so that the said coil may get warm as rapidly as possible and to the maximum temperature with a given current, while the ventilating system, by the holes  $c'$  and hot coil  $v$ , is intended to maintain the magnet  $H$  as cool as possible with a given current. The small arrows show the direction of the draft caused by the suction of the warm air issuing from the upper part of the chimney.

I claim as my invention—

1. In an electric-arc lamp, the combination, with the regulating resistance-coil and operating-magnet  $H$ , of a resistance-coil  $H^4$  in circuit with said coil  $v$  and magnet  $H$ , the resistance of the coil  $H^4$  being substantially two-thirds that of the magnet  $H$ .

2. In an electric-arc lamp, the combination, with the regulating resistance-coil and oper-

ating-magnet  $H$ , of a resistance-coil  $H^4$  in circuit with said coil  $v$  and magnet  $H$ , the resistance of the coil  $H^4$  being such that it becomes heated more rapidly than the magnet  $H$  with a given current.

3. In an electric-arc lamp, the combination, with the regulating resistance-coil and operating-magnet  $H$ , of a resistance-coil  $H^4$  in circuit with said coil  $v$  and magnet  $H$ , the resistance of the coil  $H^4$  being such that it becomes heated more rapidly than the magnet  $H$  with a given current, the said coil  $H^4$  being inclosed in a box  $a'$ .

4. In an electric-arc lamp, the combination, with the regulating resistance-coil and operating-magnet  $H$ , of a resistance-coil  $H^4$  in circuit with said coil  $v$  and magnet  $H$ , the resistance of the coil  $H^4$  being such that it becomes heated more rapidly than the magnet  $H$  with a given current, the said coil  $H^4$  being inclosed in a box  $a'$  and magnet  $H$  being in the path of a draft from the outside air to the chimney of the lamp.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 22d day of November, 1890.

JOHN H. R. WARD.

Witnesses:

W. A. COURTLAND,  
EDWARD P. THOMPSON.

R. SCHEFBAUER.  
ELECTRIC ARC LAMP.

No. 451,309.

Patented Apr. 28, 1891.

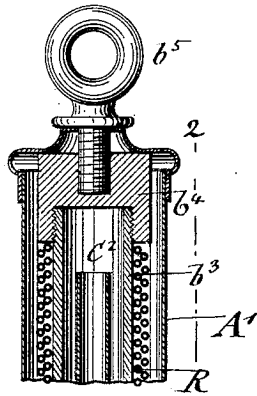


Fig. 1.

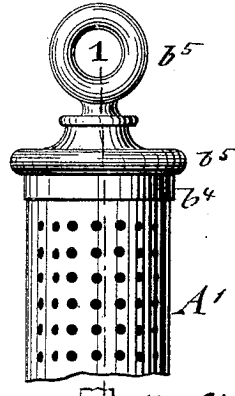
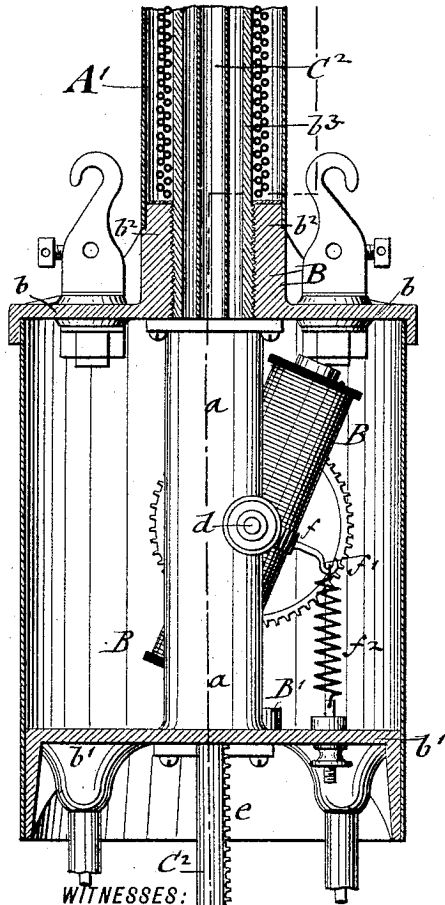
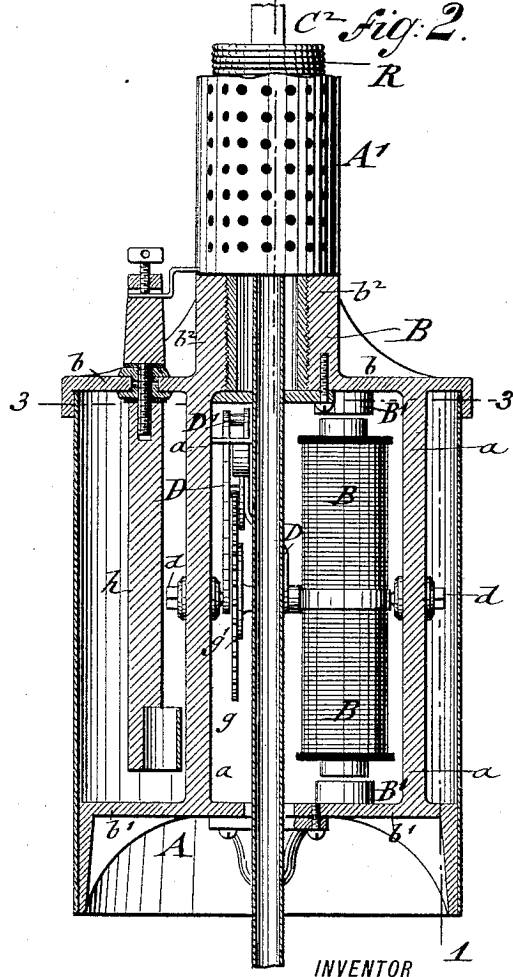


Fig. 2.



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R. SCHEFBAUER.  
ELECTRIC ARC LAMP.

No. 451,309.

Patented Apr. 28, 1891.

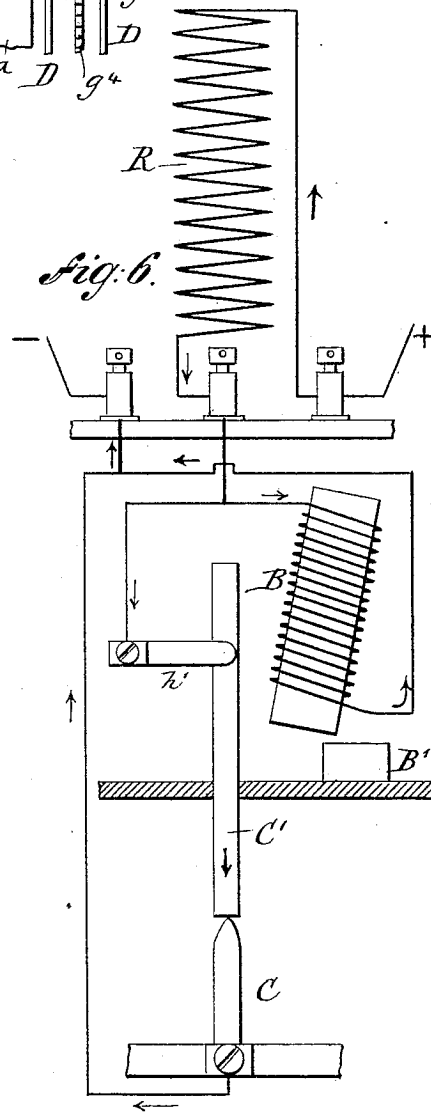
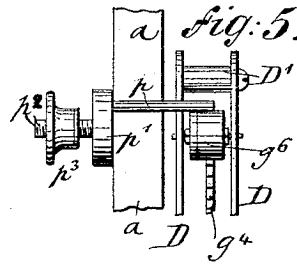
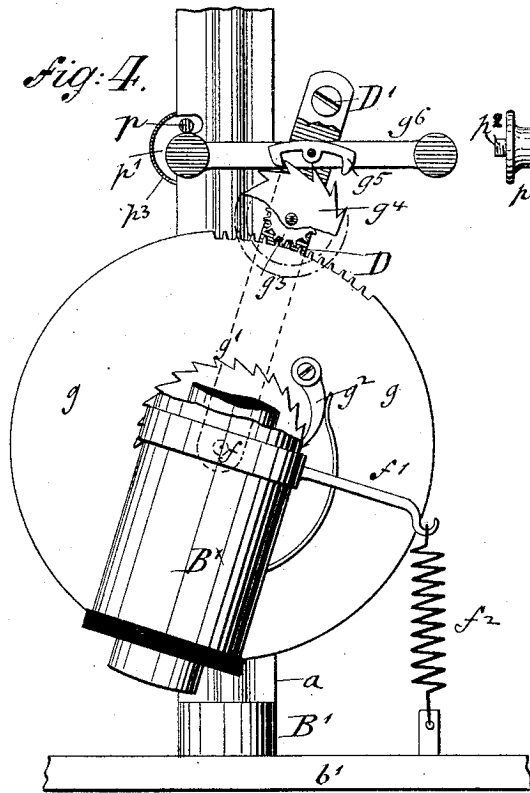
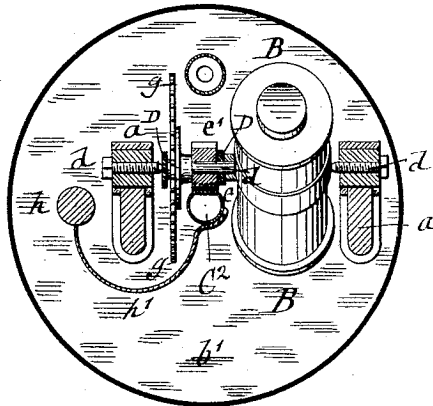


Fig. 3.



WITNESSES:

A. Seehel.  
Martin P. Key.

INVENTOR

Rupert Scheffbauer  
BY  
Lorne & Piquier  
ATTORNEYS.



# UNITED STATES PATENT OFFICE.

RUPERT SCHEFBAUER, OF PATERSON, NEW JERSEY, ASSIGNOR TO THE  
UNIVERSAL ARC LAMP COMPANY, OF NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 451,309, dated April 28, 1891.

Application filed October 3, 1890. Serial No. 366,976. (No model.)

*To all whom it may concern:*

Be it known that I, RUPERT SCHEFBAUER, of Paterson, in the county of Passaic and State of New Jersey, a citizen of the German Empire, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates to certain improvements in the electric-arc lamp for which Letters Patent were granted to me, No. 420,314, dated January 28, 1890, the improvement being designed with a view to simplify the construction of the lamp, bring the operative parts of the same within a smaller space, and render the lamp still more sensitive in responding to the varying strength of the current, so that an arc of uniform size is kept up between the carbons; and the invention consists of certain novel combinations of parts and details of construction, as will be fully described hereinafter, and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a side elevation, partly in vertical section on line 1 1, Fig. 2; Fig. 2, also a side elevation, partly in section on line 2 2, Fig. 1; Fig. 3, a horizontal section on the line 3 3, Fig. 2; Fig. 4, a detail of the carbon-actuating mechanism drawn on a larger scale, some of the parts being broken away. Fig. 5 is a detail end view of a portion of Fig. 4, and Fig. 6 is a diagrammatic view showing the arrangement of the main and shunt circuits of the lamp.

Similar letters of reference indicate corresponding parts.

Referring to the drawings, A represents the supporting-frame of my improved arc lamp, which frame is composed of two vertical pillars *a* and the disk-shaped top and bottom *b b'*, which latter are cast integral with the pillars *a a*. To the pillars *a* are applied the screw-pivots *d d*, the inner conically-tapering ends of which engage conical tapering bearings on the axle of an oscillating electro-magnet B, the coil of which is placed in a shunt of the main line. The coil of the electro-magnet may be so wound as to be either in the main line or in a shunt of the same in such a manner that a lamp on the differential principle may be obtained. The project-

ing pole ends of the electro-magnet B are attracted when the electro-magnet is energized by the current by fixed pole-pieces *B' B'*, which are cast, respectively, to the top and bottom *b* and *b'* of the supporting-frame A. The pole ends of the electro-magnet B are preferably made slightly convex, so that they are attracted easier by the stationary pole-pieces *B' B'*. The pole-pieces *B'* are arranged between the upright pillars *a* of the frame A, as shown clearly in Fig. 2. The lower carbon C of the lamp is made stationary, while the upper carbon *C'* is made movable and supported by a carbon-holder *C<sup>2</sup>*, that is provided with rack-shaped teeth *e*, that engage with a pinion *e'* on the axle of the oscillating electro-magnet B, as shown in Fig. 3.

To the axle of the electro-magnet B and sidewise of the same are further applied two fixed arms D, which are connected at their upper ends by a screw-post *D'*, said arms forming a swinging frame, which follows the motion of the oscillating electro-magnet. From a central band *f*, which extends around the electro-magnet B, extends an arm *f'* to the hook or eye, at the outer end of which is applied a spiral spring *f<sup>2</sup>*, the opposite end of which is applied to the bottom disk *b'* of the frame A, said spring serving as a tension-spring for regulating the resistance of the electro-magnet B. A gear-wheel *g* is placed loosely on the axle of the electro-magnet between the arms D D and locked to the same in one direction by a pawl-and-ratchet mechanism *g' g<sup>2</sup>*, which is clearly shown in Fig. 4, so that the gear-wheel *g* is compelled to follow the oscillating motion of the electro-magnet B in one direction without following the motion of the same when it moves in the opposite direction. The gear-wheel *g* engages a pinion *g<sup>3</sup>*, the shaft of which is supported by the arms D D, said shaft carrying an escapement-wheel *g<sup>4</sup>*, the teeth of which are engaged by the pallets of an escapement *g<sup>5</sup>*, that is applied to a balanced escapement-lever *g<sup>6</sup>*, fulcrumed to the arms D D, as shown in Figs. 4 and 5. The escapement-lever *g<sup>6</sup>* is provided with enlarged and weighted ends, so as to impart thereby a high degree of sensitiveness to the escapement *g<sup>5</sup>*. The lever *g<sup>6</sup>* is stopped by contact with a stop-pin *p*, that is applied

eccentrically to a disk  $p'$ , located on a fixed screw-pin  $p^2$  of the upright pillar  $a$ , adjacent to the arms D D, said disk being clamped by a screw-nut  $p^3$ , which serves to hold the stop-pin rigidly in position after adjustment. The carbon-holder  $C^2$  is extended through a central cylindrical bushing  $b^2$  of the top disk  $b$  in upward direction into a tube  $b^3$ , that is screwed into said bushing  $b^2$ . To the upper end of the tube  $b^3$  is applied a cap  $b^4$ , which is provided with a ring  $b^5$ , by which the lamp is suspended. The tube  $b^3$  is made of brass or other suitable non-magnetic material and surrounded by a resistance-coil R, which is inclosed by a perforated tubular shell  $A'$ , which serves to give access of air to the resistance-coil R for keeping the same cool. The resistance-coil protects the lamp against too strong a current and serves for adjusting it for the required number of ampères.

The line-wires are connected by a suitable binding-post with the top disk  $b$  of the supporting-frame A, one of the line-wires being connected to a downwardly-extending rod  $h$ , which is insulated from the top disk  $b$  of the frame A. To the lower end of the rod  $h$  is applied a bent contact-spring  $h'$ , the free end of which is placed in contact with the vertically-movable carbon-holder  $C^2$ , as shown clearly in Fig. 3, so that the line-current is conducted to the carbon-holder  $C^2$ . The current enters at one of the binding-posts and passes then through the resistance coil R, and from the same to a second binding-post, which forms the connection with the contact-spring  $h'$  of the carbon-holder  $C^2$ . The current passes then from the upper-carbon holder to the upper carbon and from the same to the lower carbon, and then along the supporting-frame A to a third outgoing binding-post and then to the line, as shown clearly in Fig. 6. The shunt-circuit branches off from the main-line wire leading from the second binding-post to the contact-spring of the upper carbon, passes around the coil of the oscillating electro-magnet, and is then connected to the outgoing wire, as shown in Fig. 6.

The operation of my improved electric-arc lamp is as follows: When the lamp is switched out of circuit, the upper and lower carbons are immediately separated, as the tension-spring of the oscillating electro-magnet returns the latter into its normal position of rest with its pole ends at some distance from the stationary pole-pieces  $B'$ , as shown in Fig. 4. The motion of the electro-magnet B lifts, by the action of the pinion  $e$  on the rack of the carbon-holder, the latter to such an extent that the arc is interrupted and the lamp extinguished. When the lamp is switched into circuit, the entire current is first passed through the shunt-circuit, as the resistance between the carbon points is too great to permit the immediate formation of the arc. As the current flows through the coil of the electro-magnet B the poles of the same are magnetized, so that they are attracted by the station-

ary pole-pieces  $B'$  to such an extent that the tension of the spring  $f^2$  is overcome. Simultaneously the escapement  $g^3$ , supported on the balanced escapement-lever  $g^6$  of the frame D, is free to be oscillated by the gear-wheel  $g$ , pinion  $g^3$ , and escapement-wheel  $g^4$ , owing to the clearing of the stop-pin  $p$  by the enlarged end of the escapement-lever  $g^6$ . The gravity of the upper-carbon holder  $C^2$  accelerates the downward motion of the same, while the escapement mechanism retards the too rapid motion of the same. By the lowering of the upper-carbon holder the contact of the carbon points takes place, upon which the entire current passes from the ingoing binding-post through the carbons to the outgoing binding-post, so that the electro-magnet is without current, which causes the same to be drawn quickly away from the stationary pole-pieces by the action of the tension-spring  $f^2$ . This lifts the upper-carbon holder by the action of the pinion  $e$  on the rack of the same, so that the points of the carbons are separated and the arc is formed. On the formation of the arc the current passes simultaneously through the main circuit and the shunt-circuit, so that the electro-magnet is energized and the pole ends of the electro-magnet B attracted to the pole-pieces  $B'$ , and thereby the electro-magnet oscillated on its pivots and the proportionate downward feeding of the upper carbon produced by the action of the gear-wheels and escapement. As the resistance of the arc increases by the burning off of the carbons, a greater quantity of current passes through the coils of the electro-magnet, so that the electro-magnet is drawn more and more inward by the stationary pole-pieces until the enlarged end of the escapement-lever  $g^6$  clears the stop-pin  $p$ , so that the escapement  $g^5$  can play and the upper-carbon holder can freely move in downward direction by gravity. By the downward motion of the upper carbon the resistance of the arc is diminished and a smaller quantity of current passes through the shunt, so that the electro-magnet B is moved away from the pole-pieces by the action of its tension-spring, and thereby the upper carbon lifted again. This produces the motion of the fixed arms D away toward its normal position of rest until the weighted end of the escapement-lever is re-engaged by the stop-pin  $p$ , so that the pallets of the escapement are prevented from releasing the teeth of the escapement-wheel, and produces thereby the arresting of the escapement of the gear-wheel  $g$  and of the upper-carbon holder  $C^2$ . The gradual burning away of the upper carbon produces again the drawing in of the electro-magnet until the train of gear-wheels is again released and the upper carbon lowered, and so on. The oscillating motion of the electro-magnet, caused by the varying resistance of the carbons and the varying strength of the current in the main and shunt circuits, serves to keep up the arc in a uniform and reliable manner.

The escapement is very sensitive, owing to the arrangement of the weighted and balanced escapement-lever and the adjustability of the stop-pin relatively to the end of said lever.

5 The pawl-and-ratchet connection of the transmitting gear-wheel *g* with the axle of the electro-magnet *B* also serves for the purpose of permitting the inserting of a carbon into the upper-carbon holder, as thereby the upper-  
10 carbon holder can be raised by means of the pawl-and-ratchet mechanism without interfering with the transmitting-train of gear-wheels.

The advantages of my improved electric-arc  
15 lamp are, first, that parts of the same are arranged in a more compact manner within the frame of the lamp than in my former construction; secondly, the **Z**-shaped armature with its segmental ends is dispensed with, and  
20 an oscillating instead of a stationary electro-magnet used in place thereof, whereby the construction is greatly simplified; thirdly, that the escapement mechanism is rendered more sensitive, so as to respond more quickly and re-  
25 liably to the requirement of the lamp, and, fourthly, that by the arrangement of the resistance-coil a better functioning of the entire mechanism takes place.

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

1. The combination of an oscillating electro-

magnet located in a shunt-circuit, a tension-spring acting on said electro-magnet, stationary pole-pieces applied to the supporting-  
35 frame of the lamp, a pinion on the axle of the electro-magnet, fixed arms on the axle of the oscillating electro-magnet, a train of gear-wheels and an escapement supported by said  
40 arm, an upper-carbon holder provided with a rack meshing with said pinion, and a stop device for said escapement, substantially as set forth.

2. The combination, with a supporting-frame having upright pillars, an oscillating  
45 electro-magnet pivoted to said pillars and located in a shunt-circuit, a tension device for said electro-magnet, a pinion on the axle of the electro-magnet, arms constituting a swing-  
50 ing frame attached to said axle, a gear-wheel placed loosely on said axle, a pawl-and-ratchet mechanism connecting said gear-wheel with the axle, an escapement mechanism for said  
55 gear-wheel, an upper-carbon holder having a rack meshing with the pinion on the axle of the electro-magnet, and a stop device for said escapement, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

RUPERT SCHEFBAUER.

Witnesses:

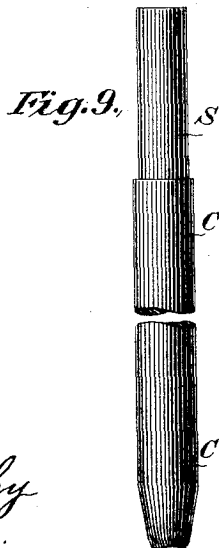
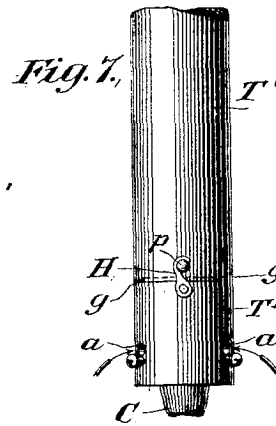
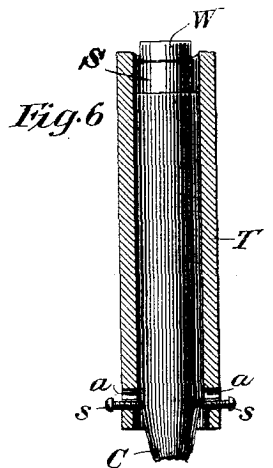
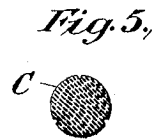
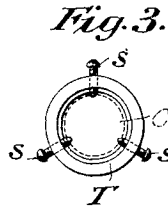
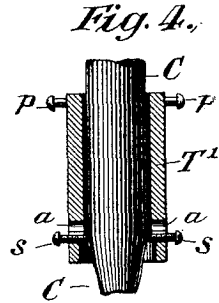
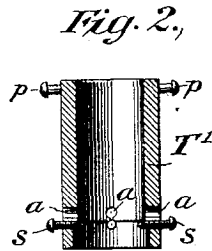
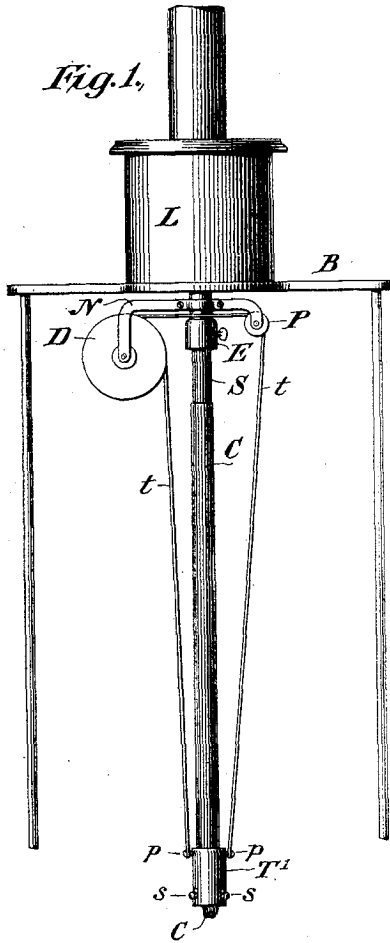
PAUL GOEPEL,  
W. REIMHERR.

(No Model.)

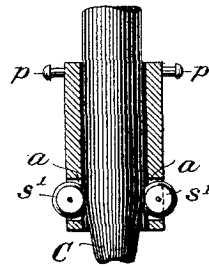
N. M. GARLAND.  
ELECTRIC ARC LAMP.

No. 458,389.

Patented Aug. 25, 1891.



*Fig. 8.*



Witnesses  
*C. E. Ashley*  
*H. W. Lloyd.*

Inventor  
*Nathan M. Garland*  
By his Attorney  
*Charles J. Kintner*

# UNITED STATES PATENT OFFICE.

NATHAN M. GARLAND, OF BOSTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO CLIFT WISE, OF NEW YORK, N. Y.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 458,389, dated August 25, 1891.

Application filed May 18, 1891. Serial No. 393,162. (No model.)

*To all whom it may concern:*

Be it known that I, NATHAN M. GARLAND, a citizen of the United States, residing at Boston, county of Suffolk, and State of Massachusetts, have made a new and useful Improvement in Arc Lights, of which the following is a specification.

My invention is directed particularly to novel apparatus for giving increased life and efficiency to arc-light carbons; and it will be fully understood by referring to the accompanying drawings, taken in connection with the specification and claims which follow.

Figure 1 of the drawings represents a side elevational view of the upper portion of any well-known form of arc lamp in which the upper carbon is fed forward as it is consumed through the agency of feeding mechanism located in a housing at the top of the lamp, one form of my improved apparatus being disclosed in connection therewith. Fig. 2 is a sectional elevational view of an arc-light-carbon protector constructed in accordance with my improvement. Fig. 3 is a plan view of the same, and Fig. 4 is a side elevational view thereof, showing a carbon in position. Fig. 5 is a sectional view of the carbon as taken on a plane through Fig. 4, in such position as to show the grooves or channels cut by the screws near the tip of the protector as the carbon is fed forward. Fig. 6 is a sectional elevational view showing the application of the invention to a positive feed-arc lamp, where the carbon is fed forward under pressure. Fig. 7 is a side elevational view of a modified form of the same. Fig. 8 is a sectional view of my improved protector provided with a modified form of feeding or regulating apparatus which supplants the screws shown in the remaining figures of the drawings. Fig. 9 is a side elevational view of my improved carbon adapted for use in connection with the apparatus illustrated in the other figures of the drawings.

Referring now to the drawings in detail, L represents a housing, such as incloses any well-known feeding apparatus for arc lights, E the carbon-carrier therefor, and C the carbon provided with a diminished shouldered end S, adapted to be held in the carbon-holder E.

T' represents my improved apparatus for protecting the tip of the carbon and giving to the latter increased life and efficiency. Said apparatus consists of a short hollow tube having substantially the same internal diameter as that of the carbon C, which it is to protect. It is made of any highly-refractory material, preferably of some refractory metal, and is provided at its upper end with a pair of pins *p*, to which are attached cords or chains *t t*, one running over a pulley P, and both to a spring-actuated drum D, said pulley and drum being carried by a two-arm support N, attached to and moving with the carbon-carrier E. The lower end of the tube T' is perforated in two or more places, as shown at *a a*, and pointed adjustable screws *s s* are secured in said perforations at the lower sides thereof, and adapted, when in place, to prevent the upward movement of the sleeve or tube T', as said screws bear against the coned end of the carbon, as clearly shown in Figs. 1, 2, and 3. The interior diameter of the protecting sleeve or tube T' should be as nearly that of the exterior diameter of the carbon C at all points above the screw-pins *s s* as possible, and is preferably larger below those pins, as shown in Figs. 2, 4, and 6, in order to admit of the free egress of the disintegrated carbon powder as the arc advances and the carbon is consumed, and also to protect the exposed end of the carbon so far as possible from the air and at the same time prevent any injurious effects upon said sleeve or tube due to the intense heat at this point. The vent-holes *a* should be directly above the screws *s s* in order to convey the air directly to the points of said pins or screws, as shown by the arrows in Fig. 7. The carbon C having been secured in place, as shown in Fig. 1, and the protecting sleeve or tube T' located in position at the point thereof, so that the pointed screws *s s* rest against the coned end thereof with sufficient bearing to prevent the sleeve or tube T' from being drawn upward by the cords or chains *t t* under the stress of the coiled spring in drum D, the apparatus is then in condition for operation. After the arc is established as the point of the carbon burns away the lower portion of the sleeve or tube T' acts as a protector therefor, and at

the same time air is admitted, as shown by the arrows in Fig. 7, through the perforations *a*, above or near the points of the screws *s s*, the air impinging upon the carbon at these points and acting in conjunction with the intense heat at the carbon points to disintegrate the carbon in grooves or channels, as shown in Fig. 5, so that the sleeve is drawn forward under the influence of the spring-actuated cords or chains *t t*, as these channels or grooves are formed. Under this action the point of the carbon *C* assumes a regular rounded end and is protected by the sleeve or tube *T'*, the latter being fed forward, as already described, as the carbon is consumed.

In the modified form shown in Figs. 6 and 7 I have shown my improved apparatus in the one instance as integral with a carbon-guiding tube *T*, which is fixed at its upper end to some support, (not shown,) while the carbon is fed forward under the influence of a weight *W*, resting on its upper end. It will be understood, of course, that a spring might supplant the weight; or the carbon might be fed by its own weight, and the arc established in this form of lamp by any well-known arc-establishing device acting upon either carbon, said device not being shown.

In Fig. 7 the protecting sleeve or tube *T'* is attached to the lower end of a fixed carbon-guiding tube *T* through the agency of a pair of hooks *H*, carried by the sleeve, and a pair of pins *p*, carried by the tube, the sleeve or tube *T'* being shouldered at *g*, as shown, so as to insure secure alignment of the two.

In the modified form shown in Fig. 8 I show a pair of V-shaped rollers *s' s'*, journaled in position in the perforations *a a* and adapted to perform the same function as the screws *s s*. These screws *s s* or rollers *s' s'* are made, preferably, of platinum, iridium, or some highly-refractory metal, and are made adjustable, as shown, in order to regulate the delicacy of the feed to be transmitted to the protecting sleeve or tube.

In Fig. 9 I have shown my preferred form of carbon, which is of the usual type, save that it is made smaller in diameter at its upper end, as shown at *S*. I make the carbon thus of diminished diameter at its upper end, so that when the protecting sleeve or tube *T'* reaches its uppermost position under the tension of the cords or chains *t t* there will be no danger of evil effects of the arc upon said sleeve or tube as the carbon is nearly consumed, by reason of the fact that the former will be drawn against the carbon-carrier *E*, leaving only the short end of the carbon to be consumed.

In the forms shown in Figs. 6 and 7 it will be readily understood that when the carbon is nearly consumed the diminished diameter will permit the weight *W* to force it forward after the screws pass the shouldered end thereof, and thus force the carbons into contact with each other, thereby acting as a short-circuiting or cut-out device.

Although I have shown the above apparatus as applicable to the upper carbon of an arc lamp, it is obvious that it might be applied to the lower carbon as well, or to both, if preferred. When used in connection with the lower carbon, the sleeve or tube *T'* would of course rest by its own weight upon the upward-projecting coned end of the carbon as it consumes away, thereby permitting the sleeve or tube *T'* to descend.

I do not limit myself to the specific construction of apparatus herein shown for accomplishing the results attained, as I believe it is broadly new with me to cause a portion of the heat generated at the arc to pass through one or more perforations in a carbon-retaining sleeve or tube, so as to impinge upon the carbon in advance of one or more carbon-retaining devices in such manner as to cause them to create grooves or channels in the carbon as it descends or as the sleeve ascends.

By the term "groove-forming retaining device" used in the claims I do not mean to cover a complete ring used as a retaining device which would scrape off a portion of the entire surface of the carbon; but I do mean to cover, broadly, one or more separate retaining devices, which may be either a point or points, or, at all events, one or more segments of circles which form one or more separate longitudinal grooves in the carbon as it is fed forward.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The described apparatus for increasing the efficiency and life of an arc-light carbon, consisting of a protecting-tube having substantially the same inner diameter as that of the carbon, in combination with one or more perforations or air-vents and groove-forming retaining devices extending into the path of the carbon near the lower end of the tube, substantially as described.

2. The described apparatus for increasing the efficiency and life of an arc-light carbon, consisting of a protecting-tube of substantially the same inner diameter as that of the carbon, provided at one end with adjustable groove-forming retaining devices and air-vents, one for each retaining device, substantially as described.

3. The described apparatus for increasing the efficiency and life of an arc-light carbon, consisting of a removable or detachable protecting-tube adapted to surround the tip of the carbon and provided with one or more groove-forming retaining devices and air-vents, one for each retaining device, for admitting air at the junction of the carbon and retaining device or devices, substantially as described.

4. A protector for the tip of an arc-light carbon, consisting of a hollow sleeve or tube of substantially the same internal diameter as the carbon, slightly enlarged at its lower end, and provided with perforations or air-

vents and retaining devices, the latter extending inwardly into the path of the carbon, substantially as described.

5 A protector for the tip of an arc-light carbon, consisting of a movable hollow sleeve or tube of substantially the same internal diameter as the carbon, provided with one or more adjustable groove-forming retaining devices, in combination with mechanism for  
10 giving to the protector a forward motion as the carbon is consumed, substantially as described.

15 6. A protector for an arc-light carbon, consisting of a movable hollow sleeve or tube of substantially the same internal diameter as the carbon and provided with two or more radial perforations and adjustable groove-forming retaining devices, substantially as described.

7. An arc-light carbon having a shouldered upper end, in combination with a carbon-protector provided with retaining devices at its lower end, substantially as described. 20

8. The described apparatus for automatically cutting out an arc lamp, consisting of a carbon-retaining tube having means at one end for sustaining the carbon against movement, a carbon located in said retaining-tube having a diminished upper end, and a lower carbon in alignment therewith, whereby when the retaining means reach the diminished portion of the carbon it will drop through and short-circuit the lamp, substantially as described. 25 30

NATHAN M. GARLAND.

Witnesses:

CHARLES J. KINTNER,  
M. C. BUTLER.

E. R. KNOWLES.  
ELECTRIC ARC LAMP.

No. 459,510.

Patented Sept. 15, 1891.

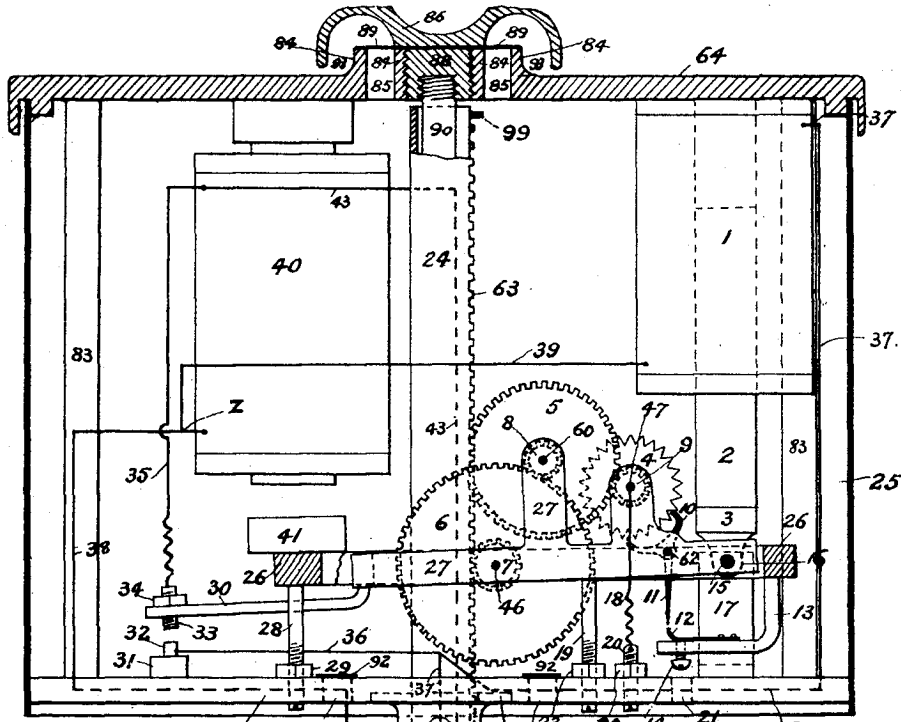
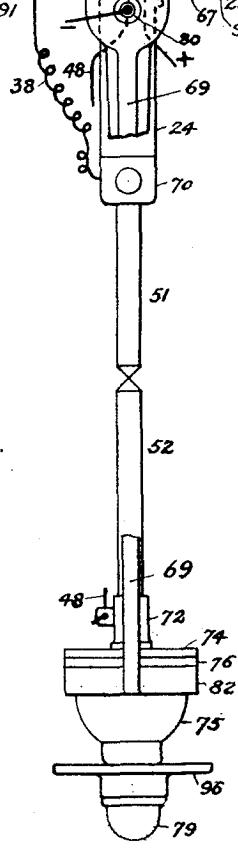
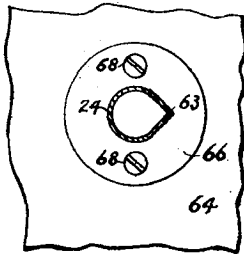


FIG. 8.



WITNESSES:  
*E. V. Meyer.*  
*C. R. Small.*

INVENTOR  
*Edward R. Knowles*  
 BY  
*James C. Webb*  
 ATTORNEY.



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ELECTRIC ARC LAMP.

No. 459,510.

Patented Sept. 15, 1891.

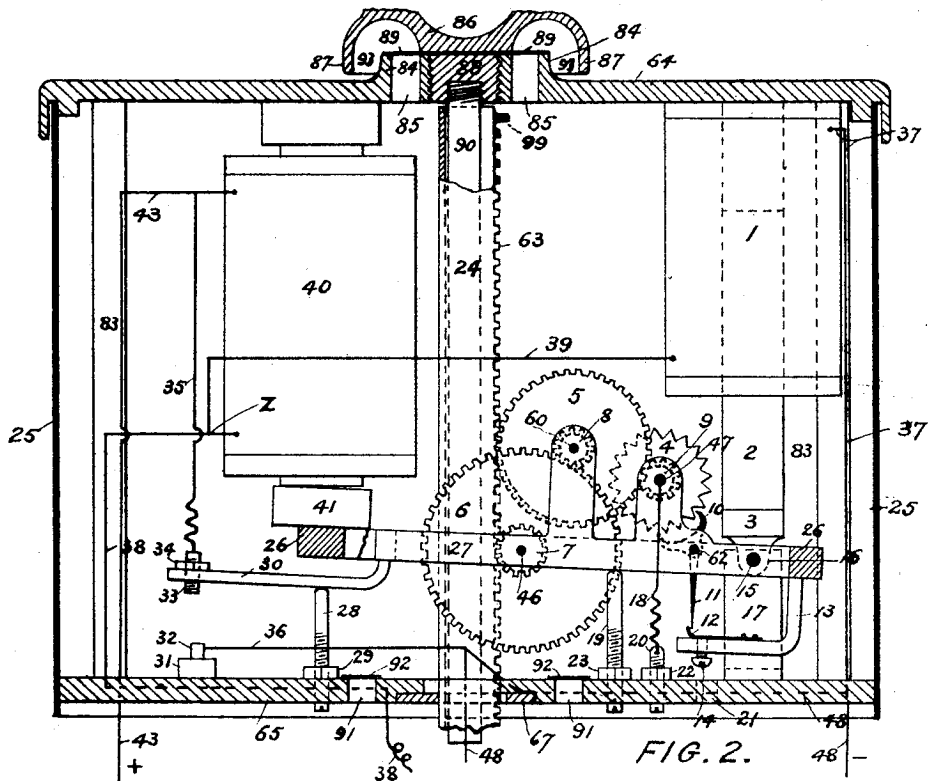


FIG. 2.

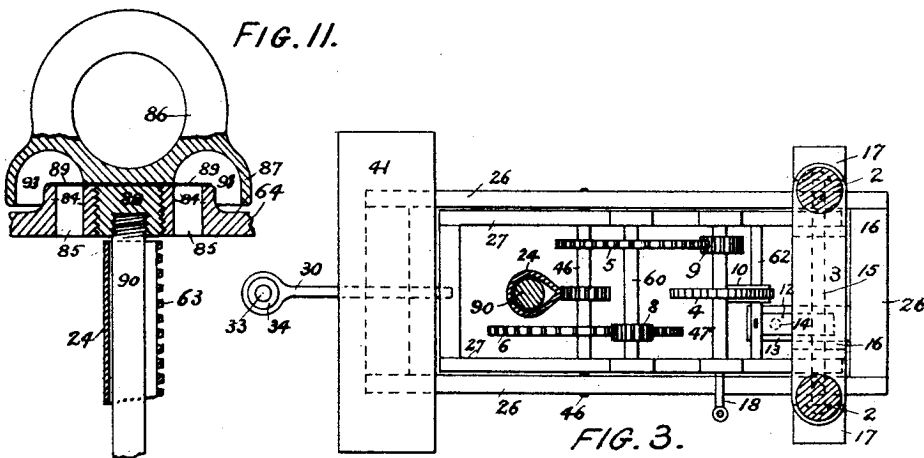
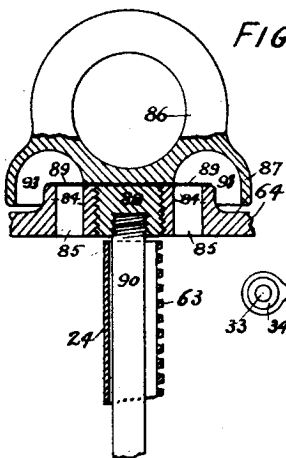


FIG. 3.

FIG. 11.



WITNESSES:

*E. V. Weyel*  
*C. A. [Signature]*

INVENTOR

*Edward R. Knowles.*

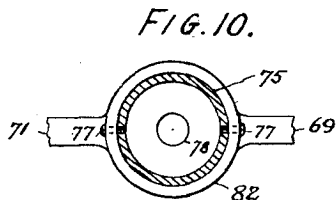
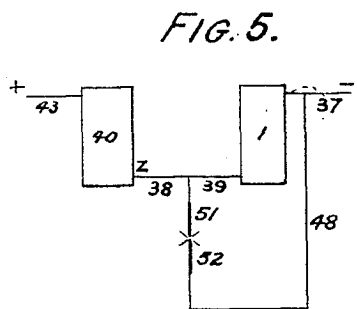
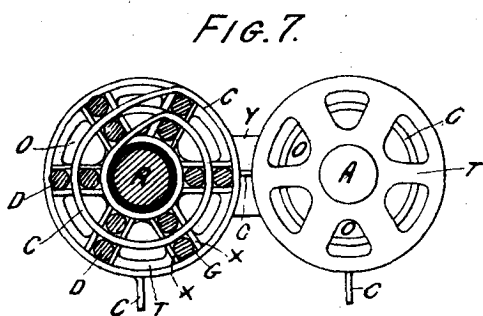
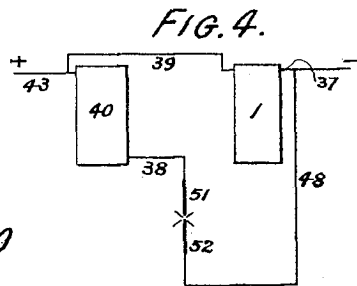
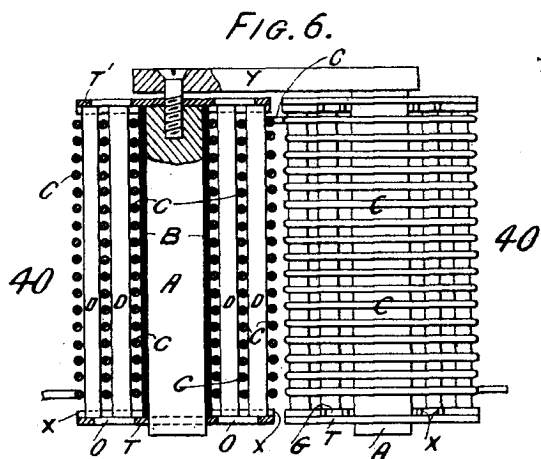
BY

*Ernest [Signature]*  
ATTORNEY.

E. R. KNOWLES.  
ELECTRIC ARC LAMP.

No. 459,510.

Patented Sept. 15, 1891.



WITNESSES:

*C. V. Myers*  
*C. R. Small*

INVENTOR

*Edward R. Knowles*

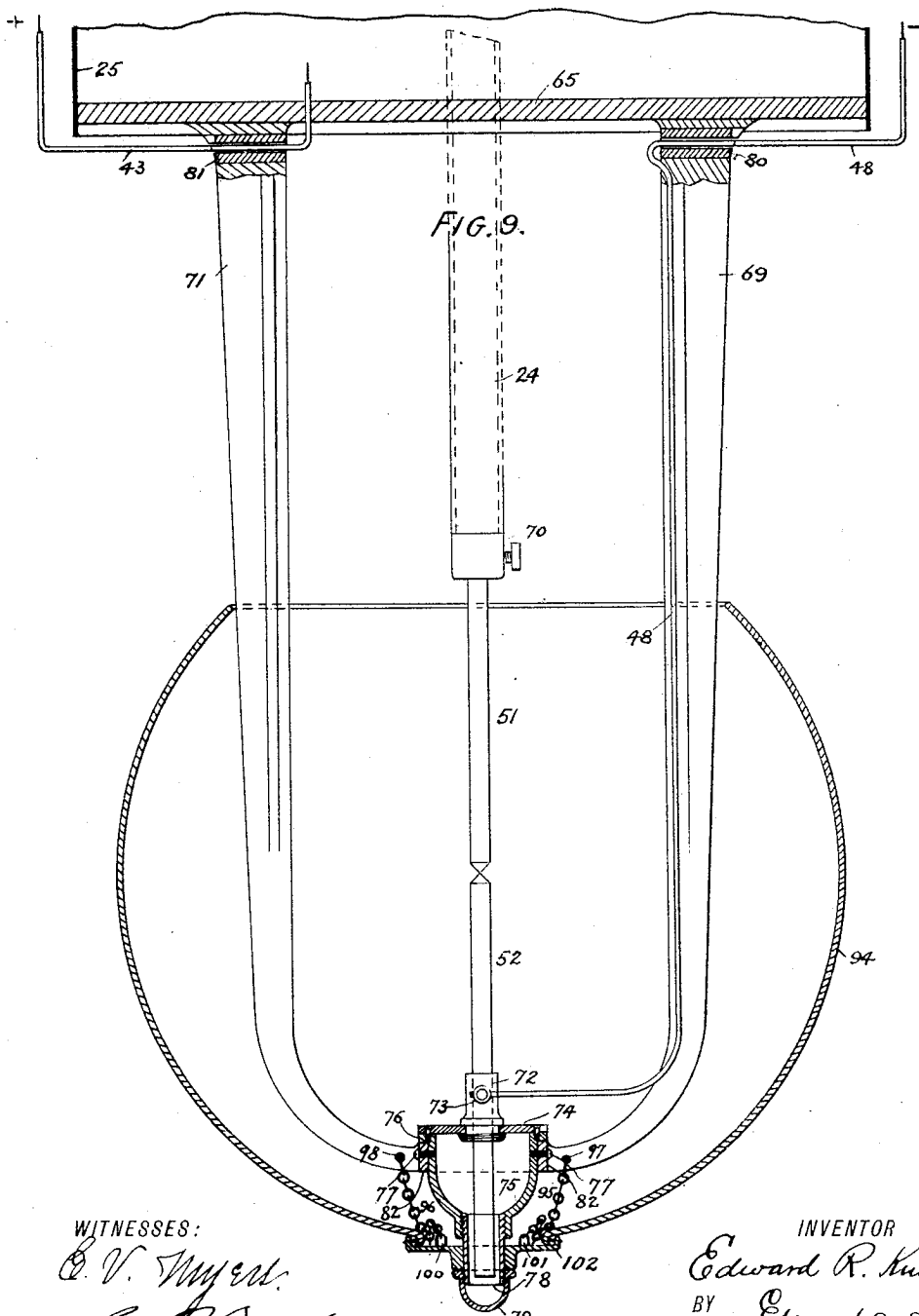
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FIG. 12.

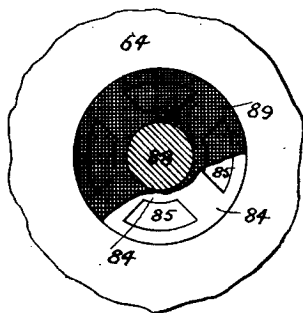
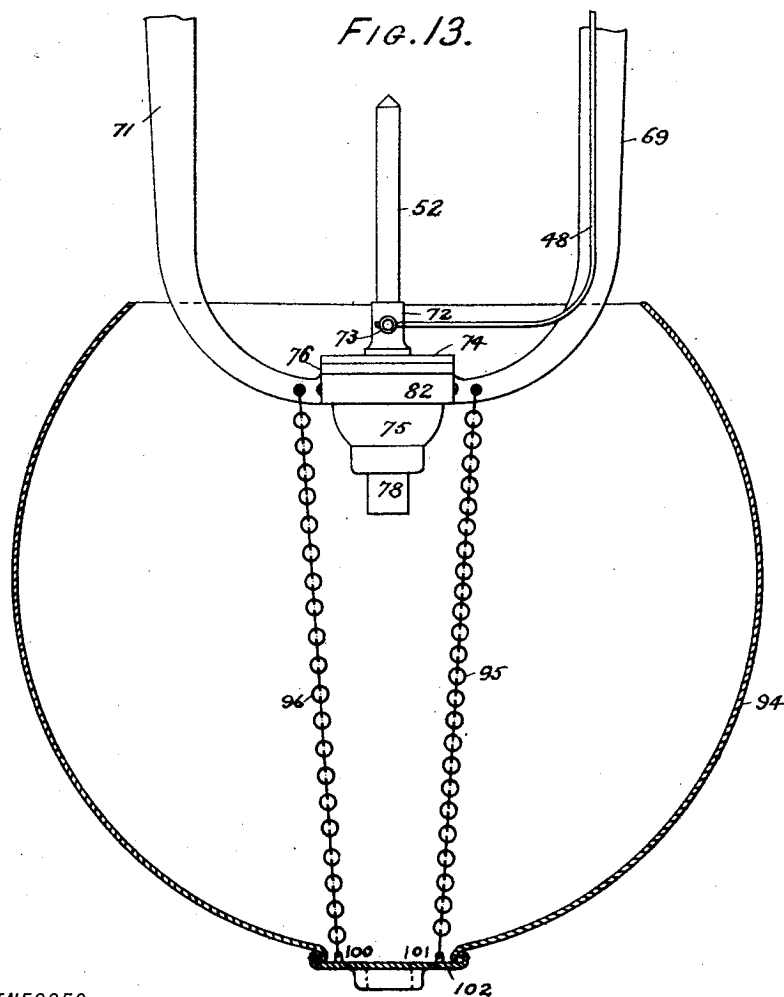


FIG. 13.



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ATTORNEY.

# UNITED STATES PATENT OFFICE.

EDWARD R. KNOWLES, OF BROOKLYN, NEW YORK.

## ELECTRIC-ARC LAMP.

**SPECIFICATION** forming part of Letters Patent No. 459,510, dated September 15, 1891.

Application filed May 25, 1891. Serial No. 394,086. (No model.)

*To all whom it may concern:*

Be it known that I, EDWARD R. KNOWLES, a citizen of the United States, and a resident of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric Lamps, of which the following is a specification.

My invention relates to improvements in electric-arc lamps of the class which are universal in their application—that is to say, lamps which are practically and efficiently operative on either an arc, an incandescent, or alternating-current circuit, as commonly known, or, in other words, what is electrically known as direct and alternating current circuits.

I seek by my invention to produce a lamp complete in all its parts, of simple, durable, and economical construction, and in which the feed and adjustment of the carbon is substantially uniform under all conditions of use, so as to insure a steady and reliable light.

To this end my invention consists of certain improvements in the mechanical construction of the lamp, the arrangement of its various parts to coact with each other, and in the circuit connections and the application of the current to effect the mechanical operations.

My invention also includes various details of construction and arrangement, which, together with the general construction of the lamp and its machinery, will be readily understood from the following description, and the points of novelty constituting my improvements will be designated in the claims concluding this specification.

In the accompanying drawings, forming part of this application, in the several figures of which like parts are similarly designated, Figure 1 is a side view in elevation of the lamp mechanism when out of action, the lamp case and frame being partly in section and partly broken away. Fig. 2 is a similar view illustrating the mechanism when in action. Fig. 3 is a plan view of the feed mechanism. Fig. 4 is a diagrammatic view of the ordinary way of making the lamp connections. Fig. 5 is a similar view of my method of making the lamp connections. Figs. 6 and 7 are views in detail of the form of electro-magnet which I prefer to use. Fig. 8 is a cross-section of the

upper-carbon rod or rack-bar. Fig. 9 is a side view, partly in section, of the lamp-frame and a central vertical section of the base of the lamp and globe-holder and supporting mechanism. Fig. 10 is a plan view of the base of the lamp. Fig. 11 is a sectional view of the suspending ring, and Fig. 12 is a plan view of the ventilating top of the lamp-case. Fig. 13 is a side view, partly in section, of the globe-holder and supporting mechanism, showing the globe removed from the lamp-frame.

The frame of the lamp is composed of a top plate 64, supported from a base-plate 65 by rods 83, and the whole is inclosed by a shell 25, these parts together forming what I shall designate as the "case" of the lamp. Attached to the base-plate 65 are the side rods 69 and 71, (see Fig. 9,) which are united together at their lower ends to form an opening 85, which is substantially ring-shaped, (see Figs. 9 and 10,) within which the base proper of the lamp carrying the lower-carbon holder 72 is supported.

Within the lamp-case, above described, is contained the operating parts of the lamp, which I will now proceed to describe.

40 is an electro-magnet, Figs. 1 and 2, of low resistance and connected in series with the main-circuit wires 43 and 48 and the carbons 51 and 52, the complete circuit being + wire 43, magnet 40, wire 38, carbons 51 and 52, wire 48, and -. The magnet 40 is preferably of special form of construction, which will be hereinafter fully described.

1 is a solenoid electro-magnet of high resistance, and is connected between a point Z, which is the inner terminal of the low-resistance magnet 40 and the negative terminal of the lamp, the circuit being point Z, wire 39, magnet 1, wire 37, and wire 48 to the negative terminal.

41 is the armature of magnet 40, and is attached to one end of a frame 26, which is pivoted at its other end at 15 to a support 17. The position of the armature 41 is regulated by raising or lowering the stop 28 and locking it in position by the set-nut 29. Inside of frame 26 is placed another frame 27, which is pivoted at 46 in frame 26 and has attached to its other end the movable core 2 of magnet 1. The position of frame 27 is regulated by raising or lowering stop 19 and locking it in

position by the set-nut 23. The pivot on which 27 is free to move is the axle 46 of the pinion 7, which passes through frame 27 and is journaled in frame 26, Fig. 2. Upon axle 5 46 is also placed a gear-wheel 6, which meshes with a pinion 8, whose axle 60 is pivoted in frame 27. Axle 60 carries a gear-wheel 5, meshing with a pinion 9, whose axle 47 is journaled in frame 27, and this axle also carries an escapement-wheel 4, which is controlled by the escapement 10, whose axle is journaled in frame 27. By this arrangement it will be seen that any movement of armature 41 will move with it frames 26 and 27 15 and all the train of gear-wheels and pinions already described, and that any movement of magnet-core 2 will move with it only frame 27, pinion 8, gear 5, pinion 9, escapement-wheel 4, and escapement 10, the axle of pinion 20 7 and gear 6 being fixed in frame 26 and frame 27 and its train of gears and pinions revolving around it as a pivot or center.

24 is a metal tube, which will be hereinafter more fully described, provided with teeth 63, 25 which mesh with pinion 7. This tube 24 is maintained in a vertical position and directed by a rod 90, attached to the top plate 64 of the lamp-case, and which fits the interior of tube 24, and over which it is free to slide, as 30 will be hereinafter more fully described, and passes through the guide-plate 67 in bottom plate 65, and carries at its lower end the carbon-holder 76, which in turn carries the upper carbon 51. The lower carbon 52 is carried by the lower-carbon holder 72 and is in 35 electrical connection with wire 48, as shown.

18 is a spring attached at one end to frame 27 and at the other end to the tension-regulator 26 22, by means of which it can be made 40 to give a stronger or weaker pull, as may be desired. This spring acts to keep frame 27 in contact with stop 19 unless it is lifted by the action of magnet 1 upon its core 2.

On the end of frame 26 is fastened the bent 45 arm 13, provided on its upper side with a detent-spring 12, which may be adjusted by means of screw 14 through an opening 21 in the frame of the lamp. The escapement 10 is provided with a downwardly-projecting lever 50 11, whose outer extremity is vertically over the detent-spring 12. When the lamp is out of action, the position of the parts is as shown in Fig. 1, frame 27 being supported by stop 19 at such a height that lever 11 clears 55 detent 12 and is free to vibrate with escapement 10; but when the lamp is in action, as shown in Fig. 2, the raising of frame 26 permits lever 11 to come in contact with detent 12, and lever 11 is thereby locked and prevented from vibrating unless frame 27 is 60 lifted by magnet-core 2, in which case it is free and allowed to vibrate.

When a current of electricity is passed through the lamp, magnet 40 is energized and 65 attracts its armature 41, thereby lifting frame 26 and with it frame 27, and all the train of gears and pinions, at the same time allowing

arm 11 to come into contact with detent 12, thereby locking the escapement and preventing the train of gearing from revolving. 70 When frame 26 is lifted, it carries with it rod 24, which has its gear 63 in mesh with pinion 7, thereby separating the carbons 51 and 52 and starting the electric arc. As the carbons burn away and the arc increases in length 75 its resistance increases, and more and more current is shunted through magnet 1 until it is energized sufficiently to draw up its core 2, thereby lifting frame 27 and the train of gearing and lifting arm 11 until it is 80 released from detent 12, thereby permitting the escapement 10 to vibrate the train of gearing to move and the rod 24 to descend until the distance between the carbons is normal, whereupon core 2 descends and 85 arm 11 is again locked by detent 12. This operation is repeated so long as the lamp is in action. When the current is cut off or ceases to pass through the lamp, the parts again resume the position which they had at 90 first. This lamp is of the non-differential type, there being in it but one variable element, the shunt-magnet 1, as shown in Fig. 1. The main magnet 40 does not vary in its action nor exert any opposing influence to 95 shunt-magnet 1, its sole function being to attract armature 41 and retain it in a fixed position during the operation of the lamp.

Attached to frame 27 is the arm 36, carrying an insulated contact-point 33, which is 100 adjustable by means of the nut 34. Immediately below contact-point 33 and upon the frame of the lamp and insulated therefrom by insulation 31 is a contact-point 32, which is connected to the other terminal of the lamp 105 by wire 32. While the lamp is burning in its normal condition these points are out of contact; but should the mechanism stick or the carbon refuse to feed as the arc grows longer and longer core 2 will be drawn farther and farther up into magnet 1 until the 110 contact-points 32 and 33 come together, when the lamp will be short-circuited, the current then passing through wire 43, wire 38, contacts 32 and 33, wire 36, and wire 48, thus cutting the lamp mechanism out of circuit and 115 preventing any possible break in the continuity of the circuit.

The method of making the connection of my lamp of which I make use is shown diagrammatically in Fig. 5, the method usually 120 employed being shown in Fig. 4. The usual method is to connect the low-resistance magnet (see Fig. 4) in direct series with the terminals of the lamp and the carbons 51 and 52, 125 the circuit being +43 40 38 51 52 48 37 -, the high-resistance magnet 1 being connected around the arc and from terminal to terminal of the lamp, the circuit being +43 39 1 37-. I have discovered that if the high- 130 resistance magnet be connected, not as shown in Fig. 4, but as shown in Fig. 5, from a point Z, which is the inner terminal of the low-resistance magnet 46, to the negative terminal

of the lamp, so that it is in series with the main magnet and the terminals of the lamp, a much more regular and steadier action of magnet 1 is obtained, the complete circuit being +43 40 Z (which is the inner terminal of magnet 40) 38 39 1 37 and —.

The side rods 69 and 71 near the point where they join the base-plate 65 of the lamp-case are enlarged, as shown in Figs. 1 and 9, and are provided with openings, into which are inserted tubular bushings 80 and 81 of any suitable insulating material, and through these bushings the lead-wires 43 and 48 are passed, 43 being carried through base-plate 65 to the magnet 40, and the other 48, being carried down along side rods 69 to the lower-carbon holder 72. By these means the lead-wires 43 and 48 are protected and all binding-posts upon the case or frame of the lamp are dispensed with, no openings through the top or sides of the lamp-case being required for the lead-wires, and the lamp is thus rendered water-proof, requiring no protecting hood or cover to shelter it, as is usually the case with lamps of this class.

The base of the lamp is preferably arranged as follows: In Figs. 9 and 10 the side rods 69 and 71 are connected at their lower ends to form an annulus or ring-shaped opening 82. This ring is bored out true on its inner surface and has inserted in it a tubular piece 75 of substantially cup-shaped form, and provided at its upper end with a side flange 76, which projects over and rests upon the upper edge of the ring-shaped opening 82 and is detachably held in place in said opening by means of set-screws 77, which can be inserted and removed at pleasure. To the bottom of the cup-shaped piece is a tube 78, which may be suitably attached thereto or formed in one piece therewith, and which serves to cover and protect the lower carbon 52 and to carry the globe-holder 102, its outer end being closed by a cap 79, which also serves to hold the globe-holder 102 in its working position. Resting upon and fastened to the flange 76 I arrange a disk 74 of any suitable insulating material, and to this disk and at about its center the lower-carbon holder 72 is properly secured. One advantage of this arrangement is that the lower-carbon holder 72 and the tubular inclosing case 75 78 for the lower carbon are all united together and can all be taken, while so united, out of the lamp-frame, if so desired, thus obviating the necessity of taking the various pieces apart. Another advantage is that these parts can be readily assembled together and adjusted before they are put in place in the lamp-frame.

The lamp-frame, consisting of the base-plate 65, side rods 69 and 71, and ring-shaped bottom 82, may, if desired, be cast in one piece, thus cheapening and simplifying the construction of the frame and rendering it easier to make the various parts true and square. I have also improved the construction of the upper-carbon rod 24, which, as shown in Figs.

1 and 8, is made in the form of a tube whose cross-section is partly round and partly square, and preferably three-quarters round and one-quarter square, with the rack-teeth 63 cut on the square edge, as shown. By this construction a gear-rod (or, as commonly called, a "rack-bar") is obtained which can be cheaply made from sheet metal or drawn as a tube, and which cannot slip or turn in the holes through which it passes like a round rod. Moreover, when a rod of this form is employed the holes through which it is to pass can be made and adjusted to conform to the shape of and accurately fit the rod, and this can be accomplished by boring the holes with a drill and fitting them to the rod by reaming them to size with a reamer and then cutting out the portion for the square edge of the rod. This cannot be done with a square or rectangular rod, such as is frequently employed.

I will now proceed to describe the construction of main magnet which I prefer to use in connection with my improved form of lamp. It consists, as particularly shown in Figs. 6 and 7, of an iron core A, which may be laminated or made of a bundle of wires or solid, as may be desired, and to which is suitably fastened at either end the metal heads T T'. These heads are of skeleton form, consisting of an outer rim T<sup>2</sup>, a central hub T<sup>3</sup>, and a series of radial arms extending from the hub to the rim. Between the arms openings O O are provided, and the under side or inner faces of the arms are scored to form a series of radial grooves G. The core A is covered with insulation and wound with a layer of any suitable wire, each layer or convolution of wire being separated from adjacent layers or convolutions by a space, as shown. Next there is placed in the grooves G rods or strips D of any suitable insulating material, and the wire C is continued in a layer upon the outer surfaces of these rods and so on until as many layers of wire C with insulating-rods D between them are wound around the core A as may be desired. The wire C may be covered with insulation or may be bare of any material desired—such, for instance, as copper, iron, or German silver. By this arrangement an electro-magnet is obtained which is perfectly insulated, is open and ventilated, and which permits of the use of a much smaller wire for a given current than is ordinarily used, as the heat generated is rapidly diffused and dissipated. Such an arrangement also admits of the magnet being made of any desired resistance by winding it with iron or German-silver wire, and this winding also permits of the use of bare wire, as none of the layers or convolutions touch one another.

When magnets of the construction above described are used in lamps of this description, more or less heat is generated, and if they are tightly inclosed in a receptacle or box, such as shown, the heat generated will

be conserved and all the other mechanism in the box will be more or less heated. To obviate this difficulty I arrange the case of my lamp in such a manner that it will be ventilated and so that a current of air can at all times pass through it, thus carrying away the heat and cooling the mechanism, and yet at the same time the box or case shall be water and dust tight. I prefer to do this in the following manner: The top plate 64 is continued up at its center in a circular boss 84, (see Figs. 11 and 12,) which is perforated by a series of openings 85, and also by a screw-threaded central opening, into which is tightly screwed or fastened the screw-threaded stem 88, forming part of the suspending-ring 86. The lower portion of this ring is cup-shaped, having on its under side a groove 93, so that when the ring 86, with stem or projecting screw 88, is screwed into place it shall form a cover to the boss 84 and the openings 85, thereby forming curved openings 85 93 from the exterior to the interior of the lamp-case 25. Between the part 86 and the screw-threaded boss 84 is inserted a disk of fine wire-gauze 89, which covers the openings 85 and prevents the ingress of dust and at the same time allows the free egress of heat and air from the interior of the lamp-case. The suspending-ring 86, together with the cup-shaped flange 87 and stem 88, is preferably all cast in one piece. In the base-plate 65 of the lamp-case are formed openings 91, also covered by fine wire-gauze 92. By this arrangement the heat generated by the electro-magnet 40 is carried off by the current of air passing in at the openings 91 in the base-plate 65 and out at the openings 85 93 in the top plate 64 of the lamp-case 25, while all ingress of dust is prevented by the wire-gauze 89, which covers the openings 85 and 91.

In order to reduce the length of the lamp and to make it as compact as possible, I dispense with the projecting tube or horn usually employed in lamps of this description and projecting from the top of the lamp-box, and from which the lamp is ordinarily suspended, and I also dispense with the tube projecting from the base of the lamp and which is usually employed to carry the globe-holder. I will now describe the way in which I prefer to accomplish these results. In order to dispense with the upper tube or horn it is necessary to make the upper-carbon rod of such a length that its upper end never passes above the top plate of the lamp-case. To provide a bearing for the upper-carbon rod, I fasten in any suitable manner to the center of the stem 88 of the suspending-ring 86 a rod 90, which is of such a diameter that it just makes a sliding fit inside the tube 24, of which the upper-carbon rod is made. This rod extends down and through the opening in the guide-plate 67, fixed in the base-plate 65 of the lamp-case. The upper-carbon rod or tube 24 passes over this rod, which serves as a long bearing for it to slide upon. By this arrangement the upper-carbon rod needs no bearing

in the top plate 64 and can slide down as the carbon 51 is consumed until its upper end reaches the pinion 7, beyond which no further sliding action can take place, its further downward motion being limited by the stop 99, which comes in contact with pinion 7. By this arrangement a bearing for the carbon-rod 24 in the top plate 64 is dispensed with, and as the rod 24 never passes above the lower surface of top plate 64 no projecting tube is needed above the top plate 64 as a cover or protection for the rod 24, and it can thus be dispensed with and the top of the lamp shortened by this much.

To shorten the bottom of the lamp and dispense with the tube usually projecting below the base, which serves as a support for the globe-holder, I prefer to arrange the globe-holding mechanism in the following manner: The projecting tube 78, forming part of the tubular base-piece 75, is made just long enough to allow the globe-holder 102 to be placed upon it and held in place by the screw-cap 79. The globe-holder 102 supports the globe 94, which incloses and passes up around the side rods 69 and 71 and base 82 of the lamp-frame. Attached to the side rods 69 and 71 at any convenient points, as 97 and 98, are two chains 95 and 96, which are attached at their other ends at the points 100 and 101 to the globe-holder 102. When the globe-holder 102 is placed in position on the tube 78, the chains 95 and 96 coil up and lie in the globe-holder 102. (See Fig. 9.) When it is desired to insert new carbons in the lamp or to get at the lower-carbon holder 72 for any purpose, the cap 79 is removed, and the globe-holder 102, and with it the globe 94, is slid down and off the tube 78 and is allowed to hang suspended by the chains 95 and 96, as shown in Fig. 13, the chains being made of such a length that the top of the globe 94 never quite clears the bottom 82 of the lamp-frame, and the globe hangs suspended in a vertical position, as shown. By this means any long projecting tube below the bottom of the lamp is dispensed with and the total lamp length shortened by this amount, and at the same time a safe means for removing and holding the globe 94 is provided.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an electric lamp having a low-resistance magnet arranged in the main circuit and a high-resistance magnet arranged in a derived circuit, the combination of an inner frame carrying the carbon-feeding mechanism and adapted to be actuated by the high-resistance magnet to operate said mechanism, and an outer frame pivotally connected to said inner frame and adapted to be actuated by the low-resistance magnet to stop the motion of said mechanism, whereby the feeding mechanism will be automatically set in operation as the current increases in strength in the high-resistance magnet and automati-



cally stopped when these conditions are reversed, substantially as described.

2. In an electric lamp, a frame movable to establish the arc, a main magnet, an armature therefor by which the movement of the arc-establishing frame is controlled, a clock-work mechanism, a supporting-frame therefor pivoted in and carried by the arc-establishing frame, a magnet in the shunt for controlling the movement of the clock-work frame, a detent carried by the arc-establishing frame for the purpose of controlling the escapement of the clock-work mechanism, and a vertically-moving rod or holder engaging the clock-work mechanism and supported in the frame of the lamp.

3. In an electric lamp, a frame movable to establish the arc, a main magnet, an armature therefor by which the movement of the arc-establishing frame is controlled, a clock-work mechanism, a supporting-frame therefor pivoted in and carried by the arc-establishing frame, a magnet in the shunt for controlling the movement of the clock-work frame, a detent carried by the arc-establishing frame for the purpose of controlling the escapement of the clock-work mechanism, and a vertically-moving rod or holder engaging the clock-work mechanism and supported in the frame of the lamp, substantially as described.

4. In an electric lamp of substantially the construction described, a removable base upon which the lower-carbon holder is supported, comprising a flanged tube the flange of which rests upon the ring-shaped bottom of the lamp-frame, an insulated plate secured to the flange of the tube, and means, such as screws, for removably uniting said base to the ring-shaped bottom, substantially as described.

5. In an electric lamp of substantially the construction described and having a ring-shaped or tubular opening in the bottom of the lamp-frame, the combination of a removable base comprising a flanged tube removably secured in said tubular opening and extending below the same, and a plate of insulating material attached to the flange of said tube and supporting the lower-carbon holder, substantially as described.

6. In an electric lamp of substantially the construction described, an upper-carbon rod composed of a tube of sheet or wrought metal whose cross-section comprises a circular segment, and two straight sides constituting an angular edge and having rack-teeth cut in the angular edge, substantially as described.

7. In an electric lamp, a frame movable to establish the arc, a main magnet, an armature therefor by which the movement of the arc-establishing frame is controlled, a clock-work mechanism, a supporting-frame therefor pivoted in and carried by the arc-establishing frame, a magnet in the shunt for controlling the movement of the clock-work frame, a detent carried by the arc-establishing frame for

the purpose of controlling the escapement of the clock-work mechanism, and a vertically-moving rod or holder composed of a tube partly round and partly square in cross-section and having rack-teeth cut in the square edge to engage the clock-work mechanism and supported in the frame of the lamp, substantially as described.

8. In an electric lamp, a frame movable to establish the arc, a main magnet connected in series with the terminals of the lamp and the carbons, an armature therefor by which the movement of the arc-establishing frame is controlled, a clock-work mechanism, a supporting-frame therefor pivoted in and carried by the arc-establishing frame, a shunt-magnet for controlling the movement of the clock-work frame connected to the inner terminal of the main magnet and in series with the main magnet and the terminals of the lamp, a detent carried by the arc-establishing frame for the purpose of controlling the escapement of the clock-work mechanism, and a vertically-moving rod or holder engaging the clock-work mechanism and supported in the frame of the lamp, substantially as described.

9. In an electric lamp of substantially the construction described, an inclosing case for the lamp mechanism, the bottom plate of which is provided with ventilating-openings 91, protected by dust and water excluding devices 92, and the top plate of which is provided with a central boss having a central screw-threaded opening to receive the stem of the lamp suspending ring, and ventilating-openings 85 arranged around said central opening, said ventilating-openings being protected by the dust and water excluding device 89, substantially as described.

10. The combination, with the ventilating-openings of the inclosing case for the mechanism of an electric lamp, of means for preventing the entrance of dirt or water into the inclosing case, said means comprising a combined suspending-ring and protecting-cover consisting of a stem screw-threaded to engage a screw-threaded opening in the case, a cup-shaped flange above the stem, and a ring above the flange, as set forth.

11. A suspending-ring and protecting-cover for the ventilated inclosing case of an electric lamp of substantially the construction shown, provided with a central screw-threaded stem below the cup-shaped flange adapted to screw into the top of the lamp-case, substantially as described.

12. In an electric lamp having an inclosing case of substantially the construction described, the combination, with the tubular carbon-rod 24, of a bearing-rod 90, suitably held in a vertical position and upon which the carbon-rod slides, as set forth.

13. In an electric lamp having an inclosing case of substantially the construction described, the combination, with the tubular carbon-rod 24, of a bearing-rod 90, upon which

the carbon-rod slides, said bearing-rod being secured at the top of the inclosing case to the stem 88 of the protecting-cover, as set forth.

14. In an electric lamp, an adjustable globe-  
5 holder comprising the globe-holding plate 102, surrounding the extension-tube of the lamp-bottom and held in place thereon by a removable cap 79, in combination with sus-  
pending-chains 95 and 96, extending from the  
10 side rods 69 and 71 to the plate 102 and

adapted to be distended and coiled as the position of the globe-holding plate varies, as set forth.

Signed at New York, in the county of New York and State of New York, this 26th day 15 of March, A. D. 1891.

EDWARD R. KNOWLES.

Witnesses:

E. V. MYERS,  
C. R. SEWELL.

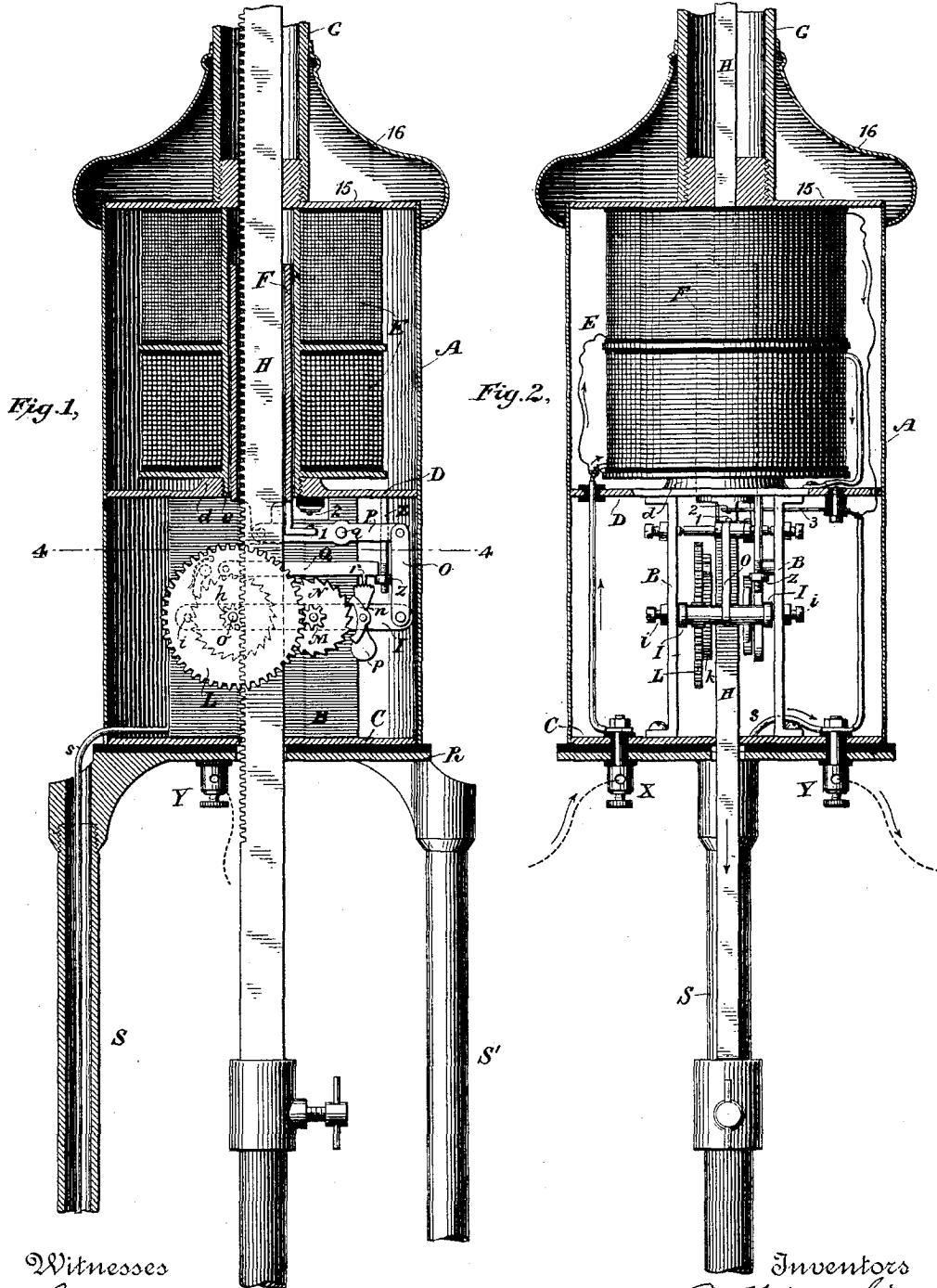
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3 Sheets—Sheet 1.

A. WIRSCHING & R. SCHEFBAUER.  
ELECTRIC ARC LAMP.

No. 461,659.

Patented Oct. 20, 1891.



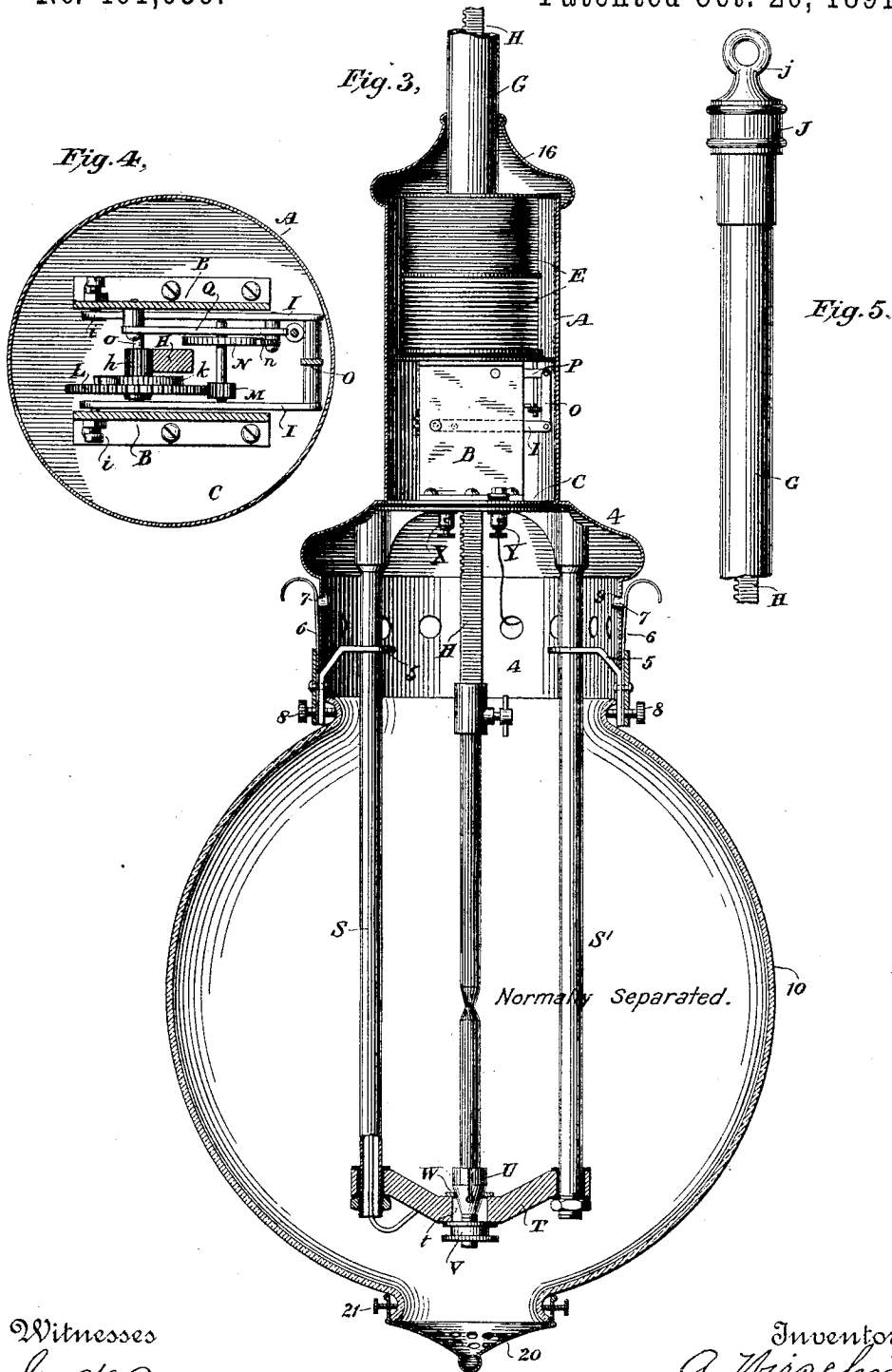
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Inventors  
*A. Wirsching.*  
*R. Scheffauer.*  
By their Attorneys  
*Fowler & Fowler.*

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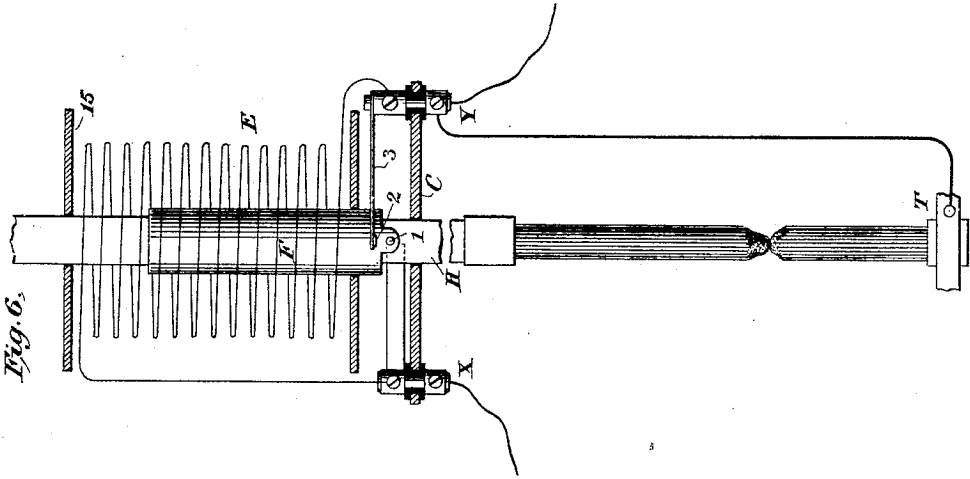
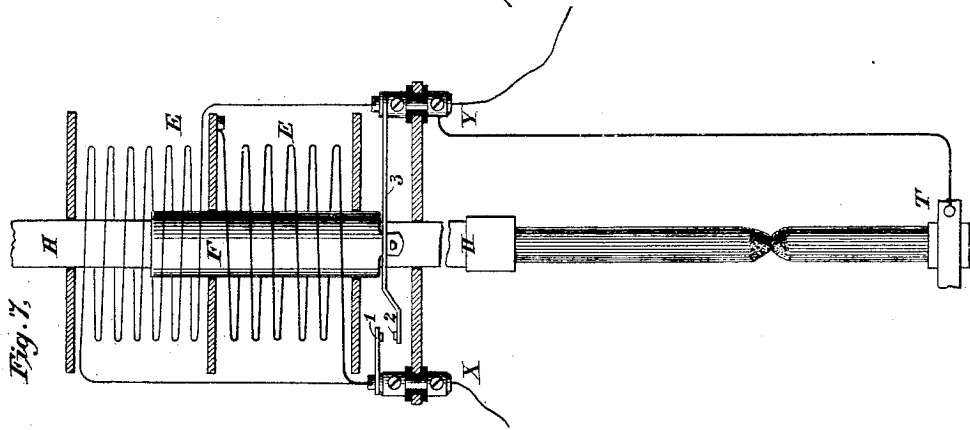
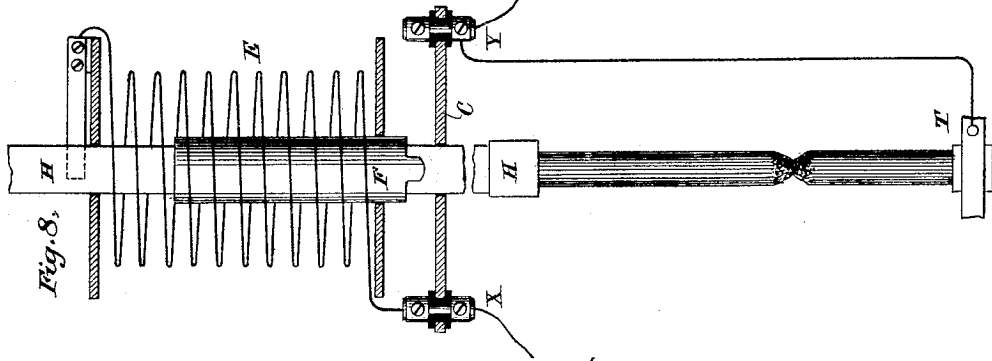
(No Model.)

3 Sheets—Sheet 3.

A. WIRSCHING & R. SCHEFBAUER.  
ELECTRIC ARC LAMP.

No. 461,659.

Patented Oct. 20, 1891.



Witnesses  
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# UNITED STATES PATENT OFFICE.

ALOYS WIRSCHING AND RUPERT SCHEFBAUER, OF NEW YORK, N. Y.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 461,659, dated October 20, 1891.

Application filed November 15, 1890. Serial No. 371,577. (No model.)

To all whom it may concern:

Be it known that we, ALOYS WIRSCHING, a citizen of the United States, residing at New York, county and State of New York, and RUPERT SCHEFBAUER, a subject of the Emperor of Germany, residing at New York, county and State of New York, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is such a full, clear, and exact description as will enable any one skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

We have invented an arc lamp having certain novel features of construction which improve both the appearance and the operation of apparatus of this class. Our design has been to construct a lamp the regulation of which should be simple and practically without sudden or spasmodic movements such as interfere with the satisfactory working of arc lamps generally. To this end we have devised a novel regulating or adjusting apparatus, which will be fully described in the specification which follows. Our lamp is also adapted to different kinds of circuits with no changes of construction. In carrying out our invention we have had in mind, also, the external appearance of the lamp, and we have given it an attractive contour.

A complete idea of our invention can be obtained from a study of the following specification, taken in connection with the accompanying drawings, in which—

Figure 1 is a vertical section of a part of our lamp, showing the feeding mechanism, including a solenoid and the clock mechanism. Fig. 2 is a front elevation showing the same parts from a point at right angles to the view in Fig. 1. Fig. 3 is a side view of the lamp, showing the lower portion thereof in detail. Fig. 4 is a sectional view taken along line 4 4 in Fig. 1. Fig. 5 is a detail view, as herein-after described. Figs. 6, 7, and 8 are views showing the different windings for different installations and voltage.

The same letters and numerals represent the same parts in all of the figures.

At A is shown a cylindrical casing inclosing the main working parts of our lamp.

Within this casing is a frame B, consisting of two similar standards placed opposite each other. The standards are secured at the bottom to a plate C, and at the top are pressed upon by a plate or ring D, which is provided centrally with a bushing *d*, as shown. The bushing is internally screw-threaded to receive the similarly-threaded lower end of the interior wall of a solenoid E, as shown. The part which we have called the "interior wall" of the solenoid projects beyond the solenoid proper and is screw-threaded for the purpose indicated. We have designated this portion of the solenoid as the interior wall to distinguish it from the movable core F, to which reference will be made hereinafter. The upper end of the solenoid is formed into a screw-thread, to which is secured the tube G, surrounding the carbon rod or carrier H. A brass cap J fits over the top of this tube and is provided with an eye *j*, by means of which the lamp may be suspended. A plate 15 at the upper end of solenoid E fits in the upper end of the cylindrical casing A, and an annular plate or collar 16, ornamentally shaped, is placed about the base of tube G and caps the upper end of the casing A, as shown in the drawings. Now the core F of the solenoid is hollow, and the carbon rod or carrier H passes through it. The said rod also passes below the core between the uprights of the frame B. The rod is rectangular in cross-section, and is serrated on one side or edge, so as to form, practically, a rack-bar, and the rack engages with a pinion *h*, as seen clearly in Fig. 1. Now the pinion referred to is mounted in a movable U-shaped frame I I, the latter being itself pivoted near its open end by means of the set-screws *i i* in the frame B. This is most clearly shown in Fig. 4. The pinion *h* is mounted on a shaft *o*, and by its side on the same shaft are a ratchet K and a gear-wheel L. The latter engages with a simple train consisting of a pinion M and an escapement-wheel N, with which an escapement *n* co-operates in the usual manner. Connected with the escapement *n* is a balanced lever *p*, the top of which is segmental in shape and notched or serrated, as shown in Fig. 1. Now the closed end of the frame I I is connected by a link O with a lever P,

pivoted at *q* and connected at its opposite end by a pivot to the core F, as shown. A detent or lever Q is pivoted at one end to the frame B and extends out over the upper end of the balanced lever *p*. On the detent or lever Q is formed a tooth *r*, which engages with one of the notches or serrations on the upper end of the balanced lever *p* and prevents all movement of the clock mechanism while so engaging. The iron core F is thus supplied at its lowest end with a lever construction, which reduces the up-and-down motion of said iron core, changing a one-half or three-fourths inch movement of the core into a one-sixteenth or one-eighth inch movement of the carbon-rod.

From the foregoing it is evident that the clock-work of our lamp is pivoted in the frame I I and that the latter is movable, its movements depending upon the position of the core F of the solenoid. When the latter is down, as it is in the normal condition of the lamp, with the carbon points separated, the clock-work is raised far enough to be stopped or detained by the tooth *r* of the detent Q. When, however, the solenoid core is raised, the clock-work will be depressed far enough to pass out of engagement with the tooth *r*, whereupon the weight of the carbon and the carbon-rod will be sufficient to cause both to descend slowly and establish contact between the two carbons. This action will be referred to again in connection with a description of the complete operation of the lamp. It should be understood, however, that the carbon rod or carrier is kept in perfect alignment by means of the guidance furnished by the bearings at the upper end of the solenoid and the lower end of the frame B—that is, the plate C. Below the plate C and insulated therefrom is a plate R, of cast-brass, to which are screwed the rods S and S', the former of which is hollow and contains a wire *s*, leading to the lower carbon. These rods are connected at their lower ends with the cross-piece T, also of cast brass, and well insulated from the rods. In the lower cross-piece is an oval or oblong slot *t*, within which the lower-carbon holder U is adapted to slide or be adjusted. The top of the carbon-holder is cut through to form the clutch. The said carbon-holder is provided with a cylindrical portion at the top, which is reamed out to receive the lower carbon and is slitted or split. Below this point it is made conical in shape and below that again cylindrical and solid, and on this last-named portion it is screw-threaded and adapted to receive a jam-nut V. This is shown in Fig. 3. In being put into place it is passed through a plate W, resting on the cross-piece T, which plate W has a circular opening and fits about, say, the middle portion of the cone. Now it is evident that if the jam-nut be put on and screwed up tight the split part of the carbon-holder will be compressed and will grasp tightly the lower end of the carbon. Owing to the presence of the oblong slot, the lower

carbon can be adjusted so as to be brought into perfect alignment with the upper, even if the latter should not be straight.

The binding-posts are shown at X and Y, X being the entering-post and Y the exit-post. These are insulated from the plates C and R, as shown in Fig. 2. The solenoid E is differentially wound, the upper part being wound with fine wire, so as to make a high resistance, and the lower part being wound with coarser wire. Now the circuit after passing the binding-post X divides, a part of it going through the fine-wire coils and thence directly to the binding-post Y and part going through the main-current winding of the solenoid E and thence to the frame and clock-work, as a contact for the carbon-rod H, and is carried through the same to the upper or positive carbon and from this through the arc or by direct contact with the lower carbon to the lower-carbon holder U, and thence by the connection-wire in the side rod S upward to the negative post Y. (See Figs. 3 and 6.)

Now the action of the lamp is as follows, it being understood that the carbons are normally separated and that it is first necessary to have the circuit established through the carbons by dropping the upper one into contact with the lower: The core F is in its lowermost position before the current is turned on. As soon as the circuit is closed the current begins to pass through the fine-wire coils, but not through the main circuit, owing to the great resistance offered by the air-space between the carbon points. Practically all the current goes through the fine wire, thus causing the core to be lifted and consequently the clock-frame to be carried down, as before described. Accordingly the carbon-rod, together with the carbon, will slowly descend until contact is made between the two carbons. At this moment, however, the majority of the current (practically all of it) will pass through the main circuit, whereby the lower part of the solenoid will become energized. This will cause a sudden dropping of the core F and a sudden lifting of the clock-frame, together with the carbon-rod and carbon. At the extremity of the lift the escapement or the lever connected with it will be caught by the tooth *r* of detent Q and the clock-work will be stopped. The distance through which the carbon is drawn by this throw or sudden movement can be regulated by means of a nut *z* on a screw-rod Z, secured in the plate or ring D, (see Fig. 1,) the nut and rod serving to regulate or limit the range of movement of the detent Q. Any influence tending to disturb the balance between the two sets of coils of the solenoid will adjust itself in the manner indicated, the principle being that of the Wheatstone bridge or balance. Thus when the arc becomes too long and the resistance by that path too great, the current or a greater portion of it will pass into the fine-wire coil and exactly the same process

above described will be repeated when placed in series and in direct high tension or high-tension alternating circuits. In case of a total destruction of the carbons or any radical irreparable detriment to the lamp it will be seen that the lamp cuts itself out by means of devices now to be described. These consist of a contact 1, formed on a projection from the lower end of the core, co-operating with a contact 2 on an arm 3, connected with the wire leading to the post Y. In this way the main wire is connected through the carbon-rod and the core with the negative binding-post without passing through the carbons. A cut-out is thus formed which will admit of other lamps in the same circuit being operated without injurious effects on account of the destruction of any given lamp.

The remaining new features of our apparatus relate to the appearance of the same and to the devices for holding the globe in place or rendering it adjustable at will. These latter will be seen in Fig. 3, where a hood 4 is shown, into which the upper end of the globe 10 normally extends. At 5 5 are shown bent guides, to which are riveted springs 6 6, which springs are provided near their tops with pins 7 7. Now this aggregation of parts, consisting of the guides or arms 5 5 and the springs 6 6, is adapted to be moved up and down upon the hood and the rods in an obvious manner. To assist in the manipulation, the springs are bent over at the top. The globe 10 is held in place by tap-screws 8 8, which pass through the lower ends of the guides and springs. When the globe is fully raised, the pins 7 7 pass through openings 9 in the hood and hold it in position. The hood 4 is perforated to ventilate the globe, which is provided at its lower opening with a removable cap 20, formed in suitable ornamental design and secured to the globe by means of thumb-screws 21. This bottom plate 20 is also formed with ventilating-perforations, and it gives a pleasing finish to the appearance of the lamp.

Such is the lamp which we have invented in its ordinary form and construction. When it is desired to use our lamp in an incandescent circuit with continuous current, it is desirable to place the lamp-resistance in the smallest possible space and at the same time to utilize it by regulating the lamp. In such cases the resistance is laid around the main winding of the solenoid coil with more or less resistance, according to the strength of the current. In high-tension circuits the construction is the same. The solenoid is supplied only with tension-winding of high resistance because such winding as a shunt permits more variation of the current and regulates particularly upon constant tension, entirely preventing any flickering or spasmodic action in the lamp. The main winding is entirely left off in order to reduce the resistance in the line and to consume all the current that may be at disposal in the arc. This form appears in Fig. 6 and has a cut-out.

For lamps to be used with alternating current from the machine direct with high tension and in series the winding is differential in the main and shunt, with the least possible resistance in the main coil, and in accordance with the strength of the current heavy wire is used, while only very thin wire is taken for the shunt. A cut-out is applied to this form of winding, which is shown in Fig. 7.

For lamps to be used with transformers with fifty volts the construction remains the same in general, only it is wound as a main-current lamp and has therefore no shunt; but the lamp-resistance is put in the main circuit. This winding illustrated in Fig. 8 employs no cut-out.

It will be understood that cut-outs are to be used only with the high-tension direct or high-tension alternating currents.

Having thus described our improvements in electric-arc lamps, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination, in an arc lamp, of a solenoid having a hollow core, a carbon-carrier passing through the said core, a clock-work mounted in a pivoted frame and engaging with said carrier, and the compound lever or link devices joining the said pivoted frame to the said hollow core, for the purpose set forth.

2. An electric-arc lamp having a rim extending from the casing proper of the lamp, rods depending from said lamp within said rim for supporting the lower carbon, retaining devices adapted to be removably secured to said rim, means for carrying at the lower end thereof a globe which makes a tight joint with said rim and incloses said rods, and arms extending from said retaining devices and loosely engaging the said rods for guiding and holding in place the globe in its lowered position, for the purpose set forth.

3. The combination, with the hood 4 or its equivalent, of the springs 6, guides 5, carbon-rods S S', and devices for attaching the lamp-globe, as set forth.

4. The combination of a solenoid, a hollow core in said solenoid, a carbon-carrier passing through said hollow core, a clock-train mounted in a pivoted frame and engaging with said carrier, a detent for said clock-train, and a compound lever connection between the pivoted frame and the hollow core, substantially as and for the purpose set forth.

5. The combination of a solenoid, a hollow core within said solenoid, a carbon-carrier passing through said hollow core, a clock-train mounted in a pivoted frame and engaging with said carrier, an escapement for said clock-train, a toothed segment on said escapement, a pivoted detent engaging with said segment, an adjustable stop for said detent, and a compound lever connection between the pivoted frame and the hollow core, substantially as and for the purpose set forth.

6. The combination of a solenoid, a hollow



core located within said solenoid and provided with a projection at its lower end, a carbon-carrier passing through said hollow core, a clock-train mounted in a pivoted frame and  
5 engaging with said carrier, a detent for said clock-train, a compound lever connection between the pivoted frame and the lower end of the core, and a contact-spring adapted to  
10 make contact with the projection on the core, so as to cut out the lamp, substantially as and for the purpose set forth.

7. The combination, with the casing, of an electric-arc lamp having an annular perforated hood at its lower end, fixed rods de-  
15 pending from said casing for supporting the lower carbon, a rim attached to the upper end

of the globe, guide-arms having perforated ends embracing the fixed rods, and springs also attached to the rim and provided with handles, and pins adapted to engage holes in  
20 the hood for releasably locking the globe-holding rim to the hood, substantially as and for the purpose set forth.

In testimony whereof we have hereunto set our hands, this 13th day of November, 1890, in  
25 the presence of the two subscribing witnesses.

ALOYS WIRSCHING.  
RUPERT SCHEFBAUER.

Witnesses:

E. L. KOLB,  
WILLIS FOWLER.

(No Model.)

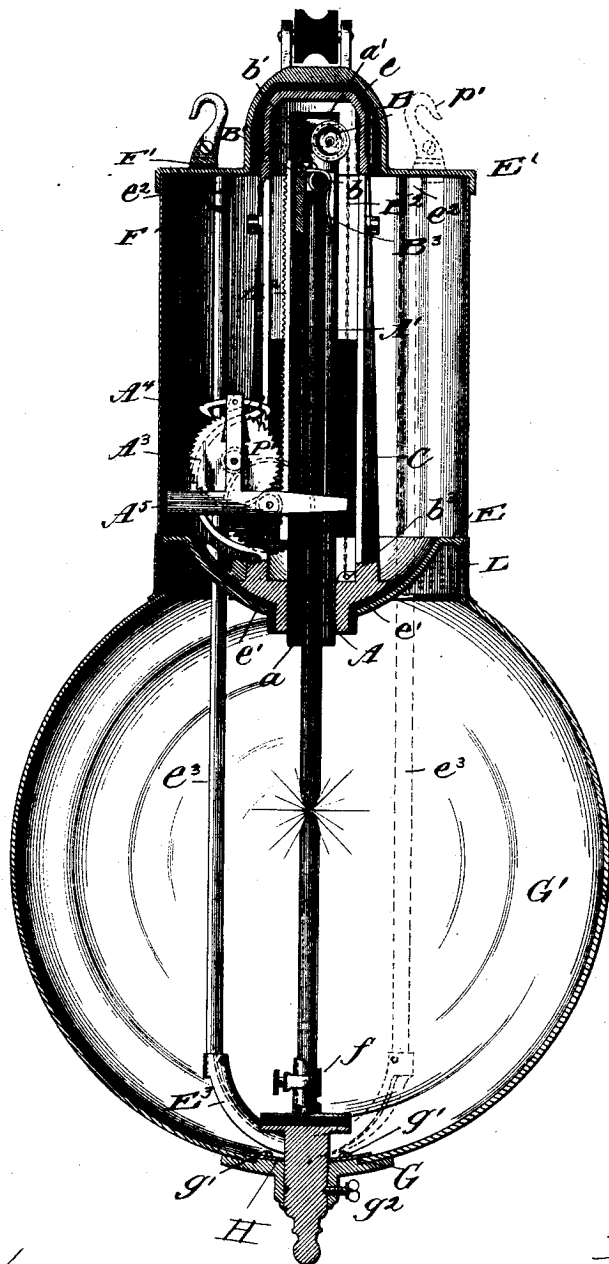
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ELECTRIC ARC LAMP.

No. 472,064.

Patented Apr. 5, 1892.

*Fig. 1.*



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Fig. 3.

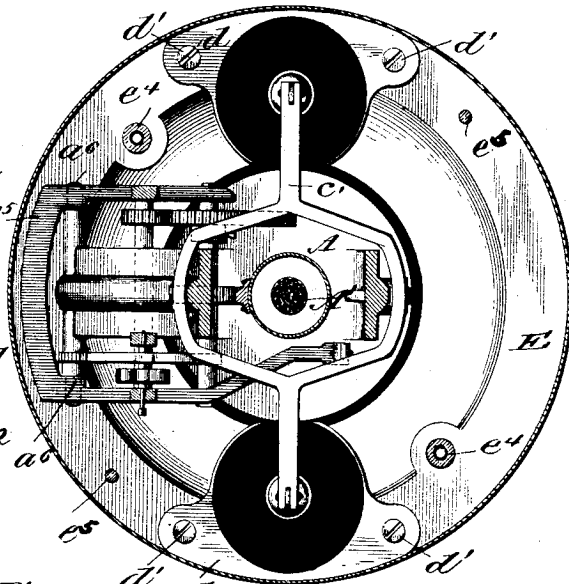


Fig. 5.

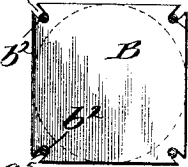
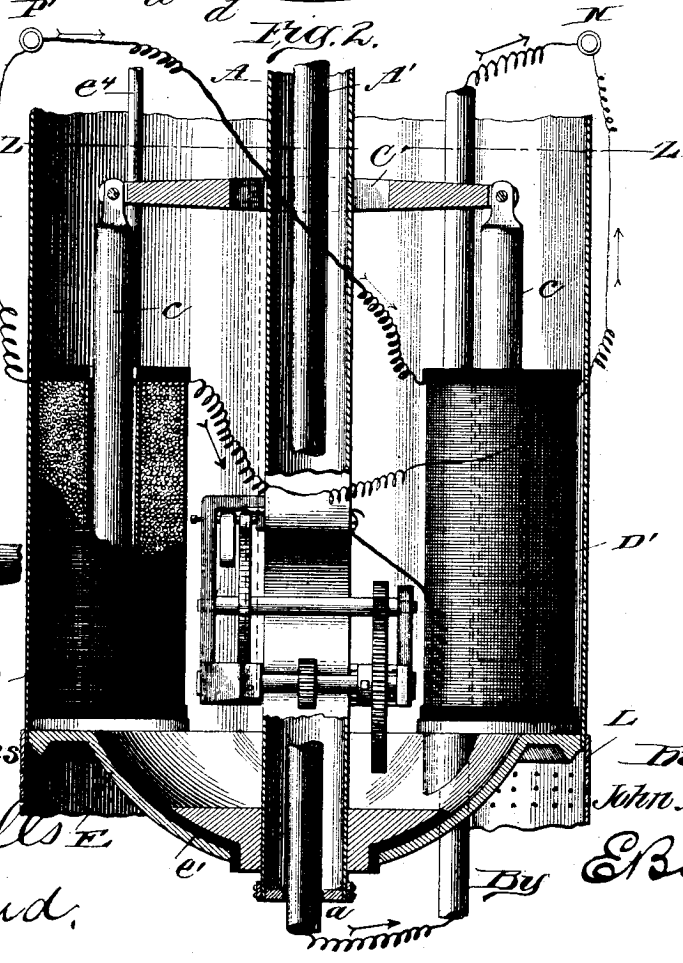
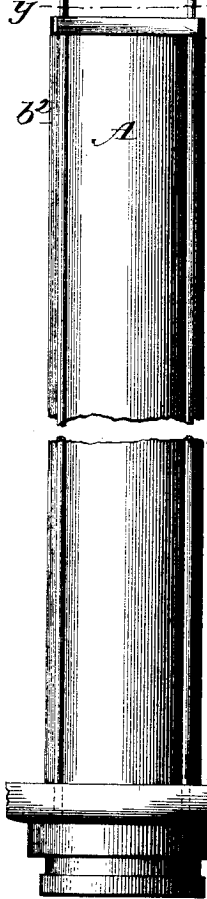


Fig. 4.



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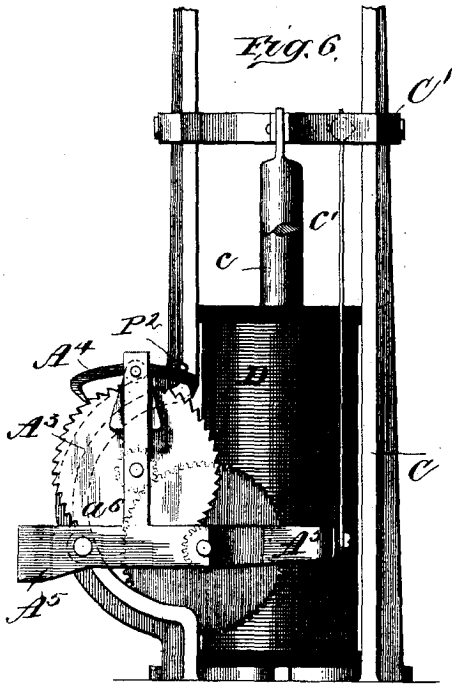


Fig. 7.

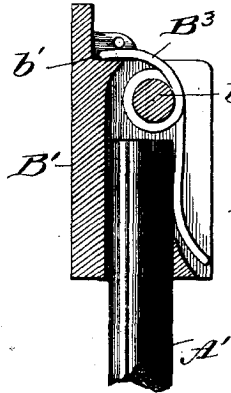


Fig. 8.

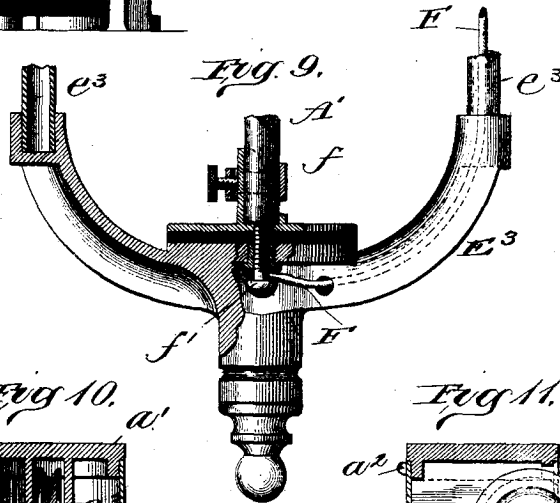
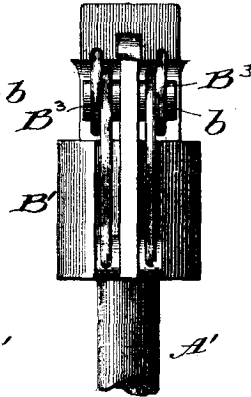


Fig. 10.

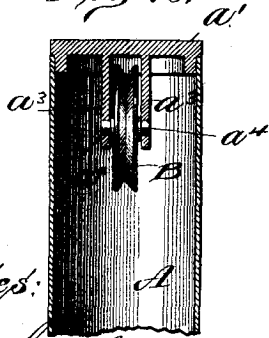
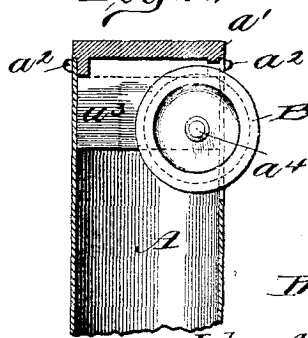


Fig. 11.



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# UNITED STATES PATENT OFFICE,

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## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 472,064, dated April 5, 1892.

Application filed June 20, 1891. Serial No. 396,950. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN A. MOSHER, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented certain new and useful Improvements in Arc Lamps, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to certain new and useful improvements in electric-arc lamps; and it has for its objects, among others, to provide an all-night lamp through the use of a single carbon only and at the same time decrease the length of lamp as commonly used. To accomplish this, I do away with the carbon rod and provide a guide for the carbon and feed both guide and carbon direct. The guide is fed downward a distance equal to half the length of the total amount of carbon consumed. The total length of lamp when constructed to burn the ordinary length of carbons—seven and twelve inches—is twenty-four inches. When constructed for all-night use, the total length is thirty-eight inches. I improve materially in the details of construction of the various parts. I simplify the same in many ways.

Other objects and advantages of the invention will hereinafter appear, and the novel features thereof will be specifically defined by the appended claims.

The invention is clearly illustrated in the accompanying drawings, which, with the letters of reference marked thereon, form a part of this specification, and in which—

Figure 1 is a vertical central section through the lamp. Fig. 2 is an enlarged sectional detail at right angles to Fig. 1. Fig. 3 is a cross-section on the line  $z z$  of Fig. 2. Fig. 4 is a detail in side elevation of the central tube. Fig. 5 is a cross-section on the line  $y y$  of Fig. 4, looking down. Fig. 6 is a detail in side elevation of the train of gears and one of the magnets. Fig. 7 is a detail, partly in section and partly in elevation, of the carbon-holder. Fig. 8 is a view looking at right angles to Fig. 7. Fig. 9 is an enlarged detail of the yoke. Fig. 10 is an enlarged detail of the upper end of the central guide-tube and its pulley. Fig. 11 is a similar view at right angles to Fig. 10.

Like letters of reference indicate like parts throughout all the views in which they occur.

Referring now to the details of the drawings by letter, A designates a tube, preferably of brass, provided with a cap  $a$  at its lower end, as shown in Fig. 1, to allow the carbon  $A'$  to pass through a hole therein. At its upper end it is provided with a head  $a'$ , resting thereon and held thereto in any suitable manner, as by the screws  $a^2$ , as seen in Fig. 11. This head is provided with downwardly-extending ears  $a^3$ , in which is supported a shaft  $a^4$ , which carries a pulley B, preferably grooved, as shown in Fig. 10.

B' is a carbon-holder. It is provided with means for the attachment thereto of a chain  $B^2$  and with a spring or springs  $B^3$ , which are coiled around a shaft  $b$ , with one end arranged to bear against the carbon, as seen best in Figs. 7 and 8, and the other end having a bearing upon a shoulder or offset  $b'$  on the holder, as shown in Fig. 7. By means of this form of holder I am enabled to put carbons in or out without manipulating a screw, this being necessary, as the carbon-holder is always confined within the tube A.

The head  $a'$  at the upper end of the tube A is constructed square, as shown in Fig. 5, with slots or notches  $a^5$  at the corners to correspond with and receive the rods  $b^2$ . These rods extend from top to bottom of the frame C and form a guide for the top of the tube A. This frame is preferably a cast frame, through the bottom of which the tube A passes, forming a guide for the bottom of said tube. The chain  $B^2$  passes over the pulley B and is connected with this frame, as shown at  $b^3$ . (See Fig. 1.)

The tube A is provided with a rack  $A^2$ , in which is engaged the usual train of gears  $A^3$ , as shown in Fig. 1, and pendulum-escapement  $A^4$ . (See the same figure.) This train of gears and escapement are mounted on a movable frame  $A^5$ , which frame is pivoted on the cast frame C, which is provided with lugs  $a^6$  for this purpose, as seen best in Fig. 3.

The frame C carries the walking-beam  $C'$ , which has attached at each end a magnet-core  $c$ . The walking-beam is connected with the movable frame  $A^5$  by the rod  $c'$ .

D and D' are the usual magnets or solenoids, D being the derived-circuit magnet, and D' the main-circuit magnet. Castings *d* are secured to the bottoms of the magnets in such a manner as to be electrically insulated from the same, and then the castings are secured to a disk E, as shown at *d'* in Fig. 3.

E' is a casting that forms the top of the lamp. It fits over the top of the frame C and is electrically separated therefrom by insulation, as shown at *e* in Fig. 1. The disk E fits the bottom of the frame C similar to the casting E' and is insulated therefrom, as shown at *e'* in Fig. 1. The casting E' is provided upon its under face with bosses *e*<sup>2</sup>, into which side rods *e*<sup>3</sup> are secured in any suitable manner, said rods passing through the disk E, which is also provided with bosses *e*<sup>4</sup> therefor, as seen in Fig. 3, and the said side rods are then passed down and are secured to the yoke E<sup>3</sup>, that forms the bottom of the lamp. The disk E is held in place by vertical rods *e*<sup>5</sup>, which are screwed into the casting E' and pass down through the disk and receive nuts. By this means the disk is drawn up, firmly clamping the frame C between the disk and the casting E', thus forming a complete frame for the lamp and also keeping the outside of the lamp insulated.

The yoke E<sup>3</sup> carries the lower carbon-holder *f*, as seen best in Figs. 1 and 9, which holder is electrically insulated from the yoke, as seen in Fig. 9, and is held in position by screw *f'*, as seen in said Fig. 9. The negative wire F is connected to this screw, and connection to the lower carbon is thus made. The wire F is passed up in the groove of the yoke, as seen in Fig. 9, and through one of the side rods *e*<sup>3</sup> and makes connection with the negative binding-post F', as seen in Fig. 1.

G is my improved globe-holder. It will be seen upon reference to Fig. 1 that the globe G has no flange at the bottom, but is left plain, with only a small hole at the bottom. The globe-holder is provided with a step or offset *g*, into which the globe rests.

H is a thin disk somewhat larger than the hole in the bottom of the globe, and this disk is secured by screws *g'* or otherwise to the globe-holder, as seen in Fig. 1, the globe and globe-holder being secured by means of set-screws *g*<sup>2</sup>, so that the globe and holder can be reversed or turned upside down and the holder replaced again on the yoke, thus allowing the trimmer to trim the lamp and dust and wipe out the globe.

On reference to Fig. 1 it will be seen that the globe extends up to the disk E, and the remainder of the space is occupied by a perforated metal or wire screen L, as shown best in Figs. 1 and 2. This screen is secured to the bottom of the outside case of the lamp and extends down to the top of the globe, thus making a spark-arrester, as well as serving to keep out bugs and the like.

P' is the positive binding-post. (See Figs. 1 and 2.)

P<sup>2</sup> is a pin or stop for the pendulum of the train of gears, as shown in Figs. 1 and 6. This stop is affixed to the frame C in any suitable manner.

The lamp works in the following manner: When the lamp is at rest, the carbons are together. When the current is turned on, it passes from the positive binding-post to the solenoid or main-circuit coil, and then to the frame C, being connected as shown in Fig. 2, making connection with the carbon. The derived circuit passes from the positive binding-post direct to the solenoid, and then to the negative post. Thus the magnet is attracted, causing the walking-beam to be tilted, which would also raise the movable frame and cause the tube A to be lifted, which would separate the carbons and form the arc. As the movable frame is raised the pendulum is brought up against the stop P<sup>2</sup>, thus blocking the train of gears. As the arc lengthens the main-circuit coil diminishes in power and there is more current forced around the derived circuit or solenoid, owing to the resistance in the arc being increased, and the derived-circuit magnet will be attracted, thus tilting the opposite end of the walking-beam, releasing the pendulum, and allowing the tube A to be lowered, thus feeding the carbon.

As the pulley B is attached to the tube A, it follows that the farther the tube feeds down and the nearer the said pulley is brought to the point of attachment of the chain to the frame the more the carbon-holder is allowed to descend down the tube, or when the tube has descended to a point so as to bring the pulley where the chain is fastened the carbon-holder will be at the bottom of the tube A instead of at the top, as it is when the tube is shoved up to its fullest extent. The carbon-holder is made heavy enough not to stick in the tube A and to always keep the chain tight. By this arrangement I only have to allow the tube A to descend just half the distance of the total amount of carbon consumed. For example, if there should be fifteen inches of carbon consumed, including both upper and lower carbons, I would only have to allow the tube A to be lowered seven and one-half inches, and the carbon-holder would also be allowed to descend down the tube A seven and one-half inches, making the distance required, so that all that is necessary to make an all-night lamp is to construct the lamp a little longer.

By making the lamp thirty-eight inches long the same length carbon can be used that is used or consumed in the usual double-carbon lamps plus about five inches, as there will only be a waste of two stubs instead of four, as in the double-carbon lamps.

Modifications in detail may be resorted to without departing from the spirit of the invention or sacrificing any of its advantages.

What I claim as new is—

1. In an electric-arc lamp, the combination, with the guide-tube and the carbon-holder arranged to move in the tube, of the movable frame carrying feed mechanism and a chain or cord attached to and supporting the holder and the other end attached to the movable frame and passed over a pulley on the tube, as set forth.
2. In an electric-arc lamp, the combination, with the guide-tube, of the carbon-holder movable within the tube, the pulley carried by the tube, means for feeding the tube, a chain or cord attached to the holder, and a movable frame supported by said chain or cord, as set forth.
3. In an electric-arc lamp, the combination, with a guide-tube and the carbon-holder movable therein, of the chain passed over a pulley on the tube and connected with the holder, and means for feeding the tube, as set forth.
4. In an electric-arc lamp, the combination, with a guide-tube and a carbon-holder movable therein, of the movable frame, the train of gears on said movable frame, and connections, substantially as specified.
5. In an electric-arc lamp, the combination, with the guide-tube and the carbon-holder movable therein, of the movable frame, the train of gears thereon for feeding the tube, the connection between the said frame and the carbon-holder, and the rack on the said tube, as set forth.
6. In an electric-arc lamp, the combination, with the guide-tube and the carbon-holder movable therein, of the movable frame connected with the tube, the walking-beam on the movable frame, and the connections, substantially as described, between the frame

and holder and between the walking-beam and tube, as set forth.

7. In an electric-arc lamp, a carbon-holder having a spring for holding the carbon and an offset for the bearing of one end of the spring, said spring being coiled around the shaft, with one end arranged to bear upon the carbon and the other in said offset, as set forth.

8. In an electric-arc lamp, the combination, with the guide-tube and the carbon-holder therein, of the rack on the tube, the train of gears for actuating the same, the movable frame on which the train of gears is mounted, and the frame to which the movable frame is pivoted, as set forth.

9. In an electric-arc lamp, the combination, with the disk E and the magnets, of the castings secured to the bottoms of the magnets and secured to and electrically insulated from the disk, the frame C, the movable frame and the feed mechanism carried thereby, and the walking-beam on the said frame carrying the magnet-cores, as set forth.

10. In an electric-arc lamp, the combination, with the disk, the magnets supported thereon, and the frame C, with its walking-beam, of the magnet-cores carried by said walking-beam, the guide-tube, the train of gears, the movable frame, the chain passed over a pulley on the tube and connected with the carbon-holder, and the stop on the frame C, as and for the purpose specified.

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

JOHN A. MOSHER.

Witnesses:

ELMER WECK,  
R. CAHN.

(No Model.)

R. M. HUNTER.  
ELECTRIC ARC LAMP.

No. 509,168.

Patented Nov. 21, 1893.

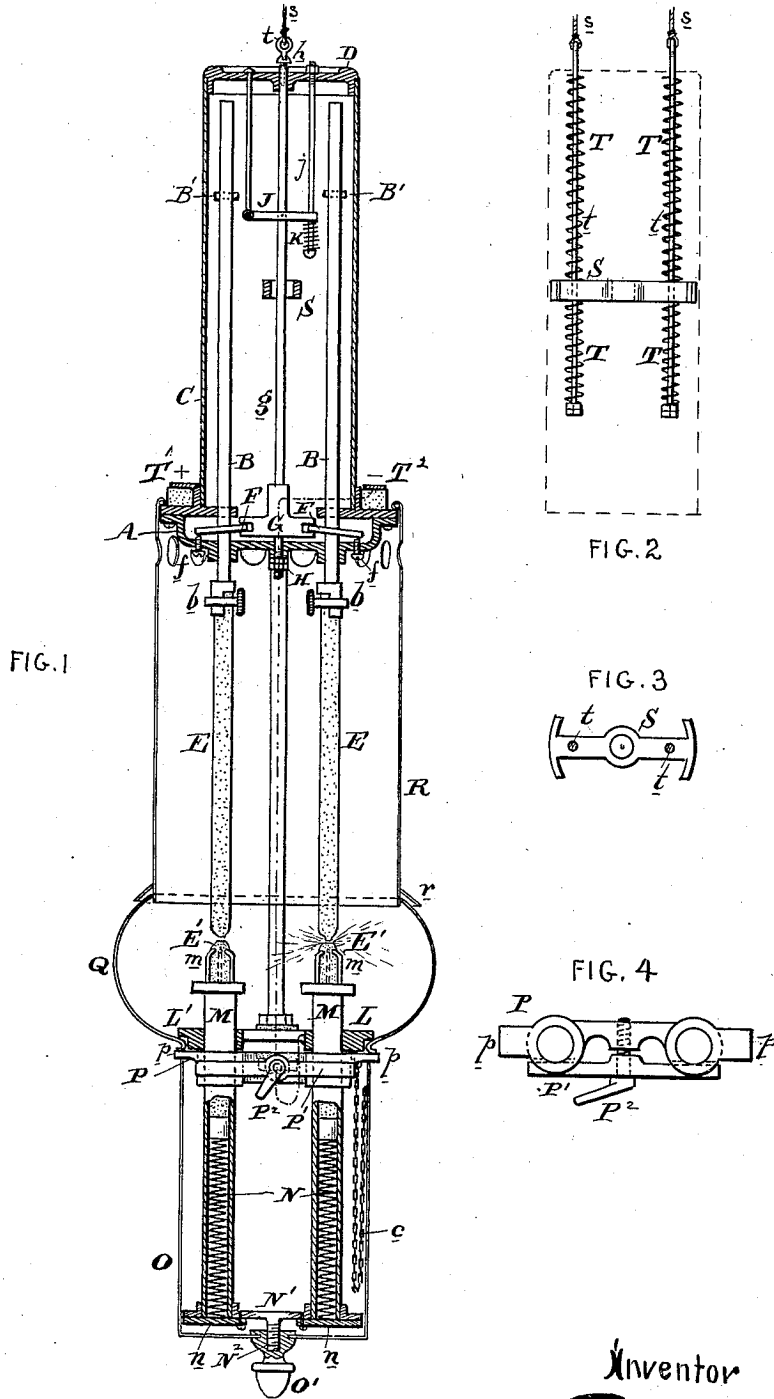


FIG. 1

FIG. 2

FIG. 3

FIG. 4

Attest  
*C. M. Wittich*  
*H. R. Matherwell,*

Inventor  
*R. M. Hunter*



# UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO  
THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 509,168, dated November 21, 1893.

Application filed June 29, 1893. Serial No. 479,118. (No model.)

*To all whom it may concern:*

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia and State of Pennsylvania, have invented an Improvement in Electric-Arc Lamps, of which the following is a specification.

My invention has reference to electric arc lamps, and consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings which form a part thereof.

This application, Case No. 257, has particular reference to arc lamps especially adapted to operate in the manner set forth in Letters Patent No. 493,360, patented to me on March 14, 1893, and while embodying the general principles of the lamp set out in said Letters Patent, being so combined with duplicate carbon holders that the lamp is what may be termed a double carbon or all night lamp.

My object is to provide a construction of lamp which shall be condensed into the smallest possible space and especially designed to be supported upon the free end of a light laterally projecting arm from a lamp post of the character set out in the aforesaid Letters Patent, and more particularly for use in connection with the lamp post structure set out in my application, Case No. 256, Serial No. 479,117, filed June 29, 1893.

My improved lamp comprehends certain constructions which are especially adapted to the lamp post set out in the aforesaid Letters Patent and in the application specified, but which are also adapted to be used in various connections and with various types of regulators.

In carrying out my invention I provide two vertical feeding rods for the two upper carbons, and two independent supporting clamps adapted to respectively operate said rods, and combine therewith a single feeding device for operating said supporting clamps for the purpose of successively feeding the two carbon holder rods. Furthermore, I provide at the lower part of the lamp two guide tubes provided with claws at the top. The negative carbons are fed up through the tubes under the action of springs and held from passing

freely therethrough by claws. The arc is thus maintained in a definite place and a very small inclosing globe may be employed. I employ a surrounding tubular casing above and below the globe for the purpose of preventing sparks flying outward, for collecting the carbon dust given off by the arc, and for ornamental appearance.

Various details of construction are specified hereinafter and are illustrated in the drawings by reference to which a better understanding of the various improvements will be had.

Figure 1 is a sectional elevation of an electric lamp embodying my invention. Fig. 2 is an elevation of the supporting devices. Fig. 3 is a plan view of a portion of the supporting devices; and Fig. 4 is a plan view of the clamp for holding the globe in position.

A is a casting of suitable shape and provided with guides for the two carbon holding rods B, B, having carbon holders *b* at their lower extremities. The casting A has secured to it upon the upper side a light tube C which acts as a shield about the rods B, B and the other apparatus of the lamp. The tube C is provided at the top with a head D.

F, F are two lifter rings of any well known construction and are adapted to be moved upward by a head G so as to lift the two rods B, B. When the head G is lowered, the rings F strike the adjustable screw stops *f* which trip the rings and allow the rods B, B to feed downward. The adjustable stops *f* are so adjusted that one ring F feeds before the other to insure one of the carbons being fed downward until consumed before the arc is formed between the second pair of carbons. The lifter head G is secured to a rod *g* which is guided at the bottom in the casting A and at top in the head or cap D. Lock nuts *h* at the bottom limit the upward movement of the rod *g* and the head G. The rod *g* is pressed upward with an elastic pressure by a cross arm J which is pivoted to the rod *g*, and at its other end is forced upward by a spring K carried upon a guide rod *j* which may be adjusted vertically to vary the tension of the spring as will be evident by an examination of the draw-

ings. The extreme upper part of the rod *g* is provided with an adjustable screw *h* which is directly actuated by the regulator in the manner set out in my patent aforesaid, and also as clearly disclosed in my pending application above referred to. It will now be understood that if the part *h* is depressed, one of the carbon rods *B* will feed its carbon *E* downward maintaining the arc between the said carbon *E* and the corresponding lower carbon *E'*. While the other carbon holder and its carbon are raised and lowered they are not moved sufficiently to cause the feeding action to the rod. After the first carbon is fully consumed, its rod is supported by the shoulder collar or pin *B'*, thereof acting in contact with the casting *A*, and remains suspended while the second carbon and its rod are fed downward by the continued action of the head *G* and rod *g*.

*L* is a bottom plate which is connected to and insulated from the casting *A* by tubular rods *l* as is customary in arc lamps. This plate *L* is provided with two vertical guide tubes *M, M* provided at their upper parts with retaining claws *m* which limit the upward movement of the lower or positive carbons *E'*.

*N* are springs adapted to press the carbons *E'* upward to compensate for their consumption. These springs *N* are inclosed within the tubes *M* and are held in position by caps *n* hinged to the under side of a cross bar *N'* carried upon the lower ends of the tubes *M*.

*Q* is a globe of glass or porcelain and is supported by an adjustable clamp *P* carried upon the tubes *M, M*. The clamp *P* is clearly shown in Figs. 1 and 4. It consists of a casting provided with two holes so as to be guided vertically upon the tubes *M* and furnished with a clamping bar *P'* pressed against the tubes by a clamping screw *P<sup>2</sup>*.

The clamp *P* is provided with lateral projections *p* which project under the base of the globe and press it upward against the annular rim *L'* of the plate *L* and thus, hold it securely in position, and at the same time permit of its easy removal. When the clamp *P* is lowered the globe descends with it, and then by a lateral shifting and depressing of one side of the globe it may be readily removed from the lamp.

*R* is a polished metallic casing provided with a series of holes near its top for the escape of hot gases and vapors and is furnished further with an inward projection at the upper portion so that it hangs upon the casing *A*, though this is not essential. The lower part of the case *R* projects slightly into the top of the globe *Q* and is provided with an outwardly extending flange *r* to shield the space between the globe and the case. I prefer to make the space between the lower end of the case *R* and the globe *Q* large enough to permit the ready passage of air so as to assist in keeping the lamp cool.

*O* is a lower casing and is adapted to fit up to the under side of the globe. It is prevented

from turning by the clamp *P*. The lower part of the case *O* is provided with a hand nut *O'* adapted to screw upon a threaded projection *N<sup>2</sup>* extending downwardly from the cross bar *N'*. When the case has been pressed up into position, the turning of the nut *O'* holds it in such position. When it is desired to insert new carbons the nut *O'* is turned to release the case *O* which is then lowered and hangs to one side by means of a chain *c*.

The dust due to the disintegration of the carbons and all cinders and sparks are retained in the lamp and collected in the case *O*. The cases *O* and *R* combined with the small globe *Q* give a very highly finished effect to the lamp in practice. By making the lower carbons feed up to the claws *m*, the arc is maintained at substantially one position, and for this reason the globe *Q* may be exceedingly small, being only the size of an ordinary globe to a gas burner. Sufficient air enters around the lower part of the lamp to keep it cool, and more or less air may be permitted to enter by providing suitable holes as may be desired.

*T*, and *T'* are the terminals of the lamp. One of these terminals is connected with the casing *C*; the other terminal is connected with the lower plate *L* as indicated in dotted lines, the conductor passing down through one of the hollow rods *l*.

The lamp is suspended in substantially the manner set out in my aforesaid patent and pending application. In the particular construction shown in this application I employ a cross bar *S* arranged within the casing *C* and provided with a large central opening through which the rod *g* freely works. The cross bar is somewhat curved upon its ends so as to fit the interior of the case *C*. Two vertical rods *t, t* are connected at *s s* to the lifting cords for lifting the lamp up to the end of the lamp post arm. Springs *T, T* encircle the rods *t* so as to sustain the lamp with an elastic support and at the same time permit the cords to be drawn tight. When the lamp enters its guides in the manner described in the aforesaid Letters Patent and application, the springs *T* hold it firmly in position so that the screw *h* is in the right position to be actuated by the electric regulator devices. It is quite evident that the lifting solenoids of the regulator, such as set out in my patent and application, Case No. 256 aforesaid, might be applied directly to the rod *g* acting as a core and inclosed within the case *C*, for the lamp is excellently adapted to permit the regulator to be arranged within its case. The special form of lamp however, is more particularly designed for use in connection with the electric lamp post wherein the regulator is supported upon the post proper and at a considerable distance from the lamp which it regulates and with which connection is made by a fine wire and levers.

While I prefer the construction shown I do not limit myself to the details thereof as

they may be modified in various ways without departing from the principles of my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, and a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position.

2. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, and a spring device to normally hold the feeding devices in an upward position and thereby suspend the carbons out of contact.

3. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, a spring device to normally hold the feeding devices in an upward position and thereby suspend the carbons out of contact, and adjusting devices for adjusting the extent of the movement of the feeding devices.

4. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, two carbon holders at the lower part of the lamp provided with claws to limit the upward movement of the carbons, and spring actuated devices to feed the lower carbons upward to compensate for their consumption.

5. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, two carbon holders at the lower part of the lamp provided with claws to limit the upward movement of the carbons, spring actuated devices to feed the lower carbons upward to compensate for their consumption, a globe, and a supporting clamp for the globe carried upon the lower carbon holders.

6. In an electric lamp, the combination of the lamp frame or case, with two carbon feed-

ing rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, two carbon holders at the lower part of the lamp provided with claws to limit the upward movement of the carbons, spring actuated devices to feed the lower carbons upward to compensate for their consumption, a globe, a supporting clamp for the globe carried upon the lower carbon holders, a dust casing inclosing the lower carbon holders below the globe, and a hand operated clamp device for adjustably securing the dust case in position.

7. In an electric lamp, the combination of the lamp frame or case, with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate both of the feeding devices and extending upward through the top of the frame or case into an exposed position, two carbon holders at the lower part of the lamp provided with claws to limit the upward movement of the carbons, spring actuated devices to feed the lower carbons upward to compensate for their consumption, a globe, a supporting clamp for the globe carried upon the lower carbon holders, a dust casing inclosing the lower carbon holders below the globe, a hand operated clamp device for adjustably securing the dust case in position, and a chain connecting the dust case with a portion of the lamp structure whereby when the case is lowered it hangs to one side to permit the ready renewal of the carbons.

8. In an electric lamp, the combination of the lamp frame or case with two carbon feeding rods provided with carbon holders, feeding devices for each of the rods, a vertically movable part adapted to operate the feeding devices and extending upward through the top of the frame or case into an exposed position, two carbon holders at the lower part of the lamp provided with claws to limit the upward movement of the carbons, spring actuated devices to feed the lower carbons upward to compensate for their consumption, a globe, a supporting clamp for the globe carried upon the lower carbon holders, a dust casing inclosing the lower carbon holders below the globe, hand operated clamp device for adjustably securing the dust case in position, and an upper removable case arranged between the upper part of the frame or case of the lamp and the top of the globe whereby the upper carbons are inclosed and sparks retained.

9. In an electric lamp, the combination of the main frame of the lamp, upper carbon holders and their feeding devices, two vertical tubular holders for the lower carbons provided with retaining devices at their top, springs to press the carbons upward through said tubular holders, a vertically movable guide clamp guided upon the tubular hold-

ers and movably clamped thereon, and a globe supported by said clamp and adapted to be clamped between a portion of the main frame and the adjustable clamp.

5 10. In an electric lamp, the combination of the casting or frame A having guides for the vertical feeding rods B B provided at their lower parts with carbon holders, the upwardly  
10 extending tube or case C provided at the top with a cap or head D, suitable feeding devices for the carbon holder rods B B, a vertical  
spring actuated feeding rod *g* arranged within the tube or case C and extending upwardly  
15 through the top of the head D, and suitable lower carbon holders.

11. In an electric lamp, the combination of the main frame provided with a tubular casing at the top, the upper feeding rods for the  
20 upper carbons and the feeding devices therefor, inclosed by said casing, a transverse bar arranged within the casing, two lifting rods extending down into the casing and through  
the transverse bar, and springs encircling the said rods for supporting the lamp with an  
25 elastic support.

12. In an electric lamp, the combination of the upper carbon holders and upper feeding

devices, with two tubular holders for the lower carbons, a cross bar at the bottom of the tubular holders, a dust case inclosing the lower  
30 parts of the tubular holders, and a hand operated clamping device between the case and the cross bar for detachably holding the dust case to the said cross bar.

13. In an electric lamp, the combination of  
35 a main frame, a lower tubular carbon holding guide having claws or stops at its upper part to limit the upward movement of the lower  
carbon, a spring or upward pressure device for feeding the lower carbon upward, a vertically  
40 movable feeding rod and holder for the upper carbon, feeding devices for operating the upper carbon rod, and a globe inclosing the adjacent ends of the upper and lower  
45 carbons supported by the lower carbon holder and having a vertical height less than the length of movement of the feeding rod for the upper carbon.

In testimony of which invention I have hereunto set my hand.

R. M. HUNTER.

Witnesses:

HELEN L. MOTHERWELL,  
ERNEST HOWARD HUNTER.

W. J. DAVY.  
ELECTRIC ARC LAMP.

No. 521,877.

Patented June 26, 1894.

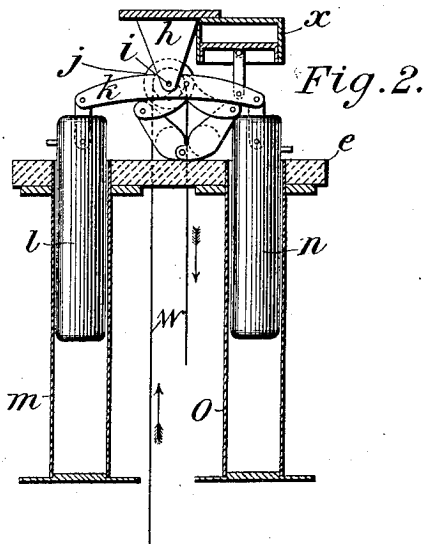
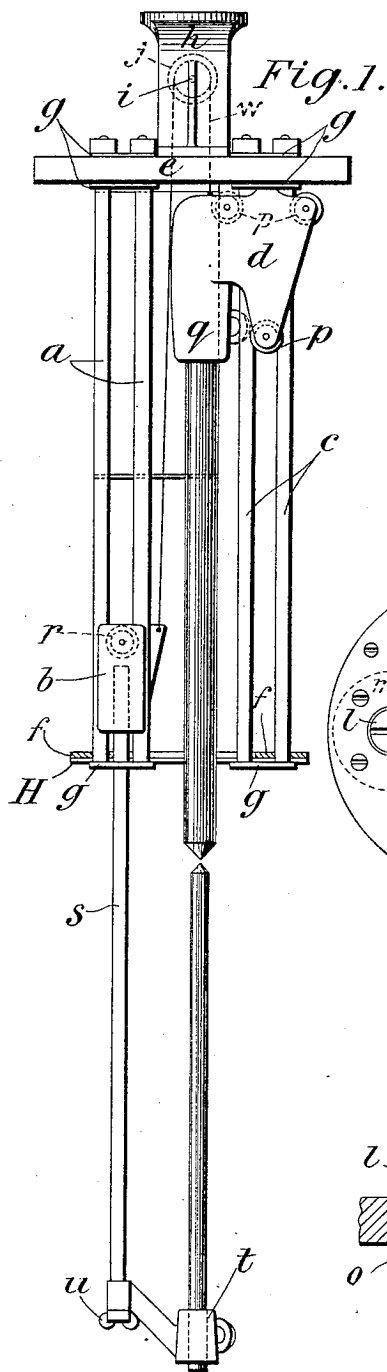


Fig. 3.

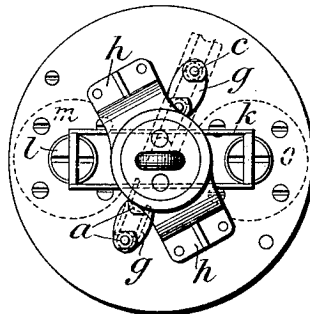


Fig. 4.

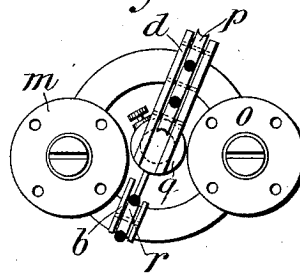


Fig. 5.

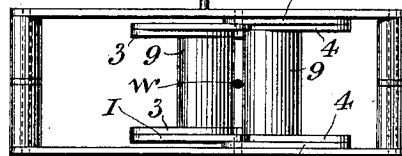
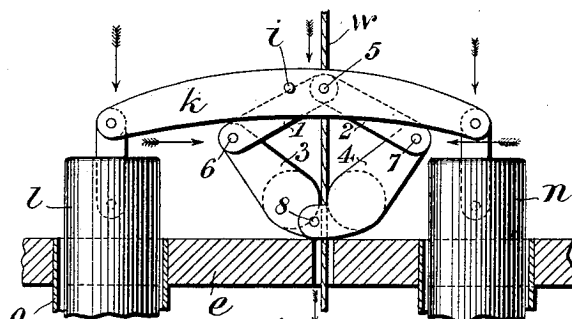


Fig. 6.

WITNESSES.  
John F. Cairns.  
Albert Jones.

INVENTOR  
William J. Davy  
By his Attorneys.  
Wheatley & Mackenzie

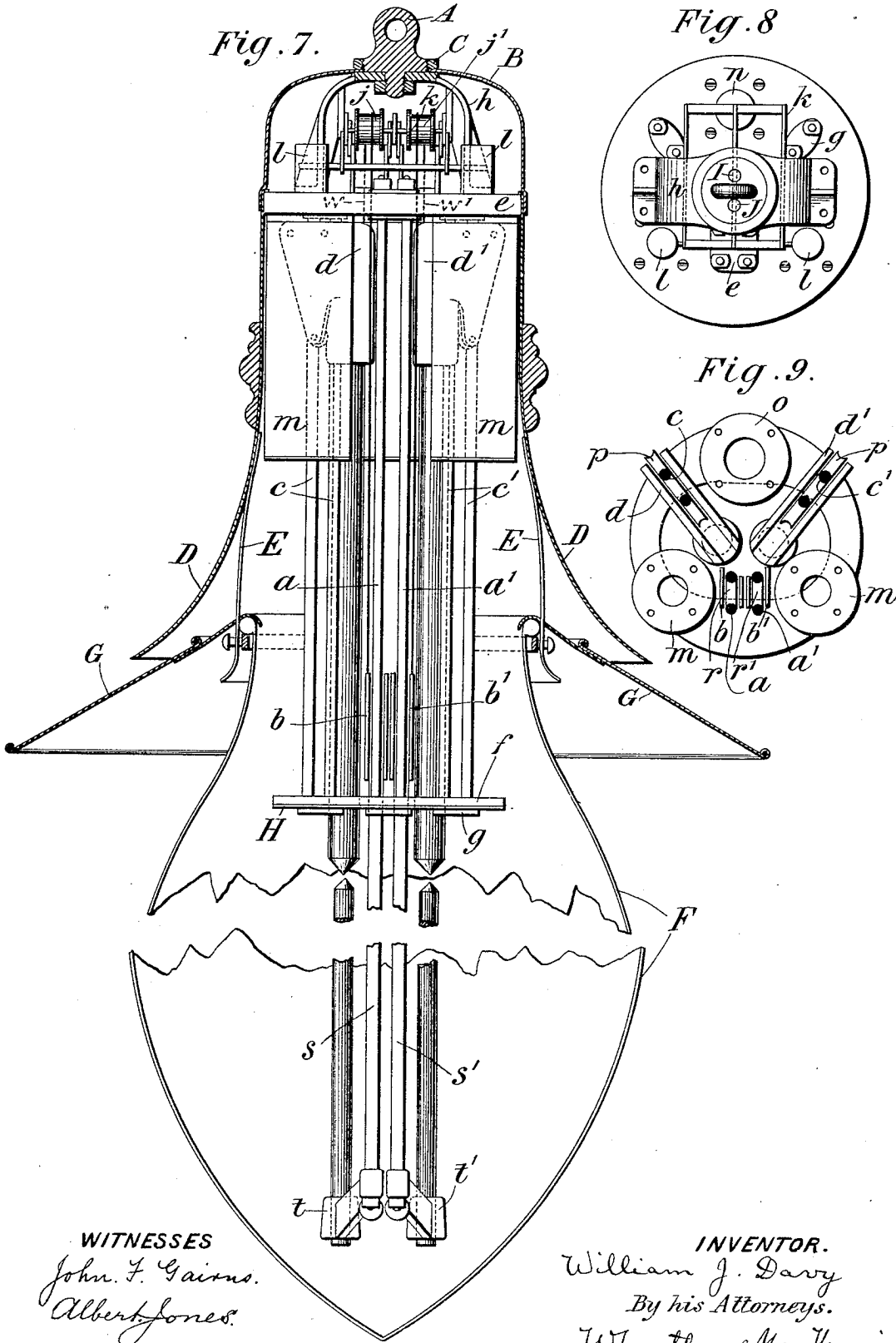
W. J. DAVY.  
ELECTRIC ARC LAMP.

No. 521,877.

Patented June 26, 1894.

Fig. 7.

Fig. 8



WITNESSES  
John F. Gairns.  
Albert Jones.

INVENTOR.  
William J. Davy  
By his Attorneys.  
Wheatley & MacKenzi

# UNITED STATES PATENT OFFICE.

WILLIAM J. DAVY, OF LONDON, ENGLAND.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 521,877, dated June 26, 1894.

Application filed April 14, 1894. Serial No. 607,611. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM JAMES DAVY, a subject of the Queen of Great Britain, residing at 161 Huddleston Road, Tufnel Park, London, in the county of Middlesex, England, 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.

This invention for improvements in electric arc lamps relates to focusing lamps in which the positive and negative carbon holders are connected together by a cord passing over a pulley and in which the upper carbon holder tends to descend by gravity and thus at the same time to draw up the lower carbon holder so as to bring the two carbons into contact; and consists in an improved arrangement for striking and maintaining constant the arc consisting of a gravity friction grip device acting on the cord and regulated by series and shunt solenoids.

In the accompanying two sheets of illustrative drawings:—Figure 1 is an elevation, the hood shades, solenoids and friction grip brake being supposed removed, of a single lamp constructed according to this invention. Fig. 2 is a sectional elevation of the solenoids and friction grip brake. Fig. 3 is a plan of the upper part of the lamp with the hood removed. Fig. 4 is a plan of the travelers and their guides and of the solenoids. Fig. 5 is an elevation of the gravity friction grip device, and Fig. 6 is a plan of the same. Fig. 7 is a sectional elevation of a duplex lamp constructed according to this invention and Fig. 8 is a plan of the upper part of the lamp and of the friction grip devices, and Fig. 9 is a plan of the travelers and its guides and the solenoids.

The guide rods *a* for the lower carbon traveler *b* and the guide rods *c* for the upper carbon traveler *d* are secured to the non-conducting disks *e* and *f*, the distance between the rods *a* and also between the rods *c* being determined by the tie washers *g*.

Mounted in projections depending from a saddle bracket *h* secured to the disk *e* is a spindle *i* which carries the loose cord pulleys *j* and the fixed regulating brake levers *k* con-

nected by links at one end to the core *l* of the series solenoid *m* and at the other end to the core *n* of the shunt solenoid *o* both solenoids being carried from the under side of the disk *e*.

By using non-conducting disks or supports the several parts of the lamp are thoroughly insulated from one another and a sound solid frame obtained.

The upper carbon traveler *d* is guided by means of small grooved rollers *p* fixed at the extremities of the traveler *d* and bearing on the rods *c* and carries the upper carbon holder *q*. The lower carbon traveler *b* is guided by a single grooved roller *r* mounted at its upper end and bearing between the two rods *a* and is attached to a depending tail rod *s* having a tapered end on which is secured the lower carbon holder *t* by the fly nut *u*. The two travelers *b d* are connected together by the cord *w* passing over the loose pulley *j* and between the friction grip device carried by the levers *k*. The guiding arrangement allows of the use of longer carbons or the reduction of the length of the lamp and the method of attaching the lower carbon holder enables the carbons to be easily set in line.

The friction grip device consists of the four pairs of links 1, 2, 3, and 4 jointed together at the points 5, 6, 7, and 8 and suspended from the regulating levers *k* at the point 5 at a slight distance from the spindle *i* forming the fulcrum of the regulating levers *k*. Each pair of lower links carries a jaw or grip between which the cord *w* passes. Normally the jaws rest on the plate *e*.

The operation of the grip device is as follows:—On the current passing to the lamp the core *l* of the series solenoid *m* is drawn down and by means of the regulating lever *k* draws up the point of support 5 of the friction grip links. This motion of the point 5 causes the jaws 9 to grip the cord *w* the jaws still resting on the plate *e*. As soon as the jaws grip the cord the relative motion of the points 5, 8 is stopped and the whole friction grip device is raised with the point 5 and raises with it the cord *w* and so the arc is struck. As the resistance of the arc increases due to the burning away of the carbons and consequent lengthening of the arc the power of the series solenoid decreases and gradually the friction grip device is lowered on to the

plate *e* and the jaws begin to relax their hold on the cord *w* and a continuous and steady feed is obtained by the cord feeding slowly through the jaws 9. If the lamp is working in series the shunt solenoid *o* which is connected across the terminals of the lamp helps to feed the carbons together and maintain a steady arc. In order to still further increase the steadiness of the arc the piston of a dash pot *x* is attached by a link to the regulating lever *k*.

The duplex lamp shown in Figs. 7, 8, and 9, is actuated by one striking and regulating mechanism there being two sets of travelers *b b'* and *d d'* and carbons, two cords *w w'* and pulleys *j j'* and two friction grip devices actuated by one set of regulating levers *k* and solenoids *m o*. The duplicate parts are similar to those described for the single lamp and are indicated respectively by the same reference letters the second set being indicated by a dash to the letter. Also two series cores *l l'* and solenoids *m m'* acting together are shown. The lamp is suspended by the eye A screwed into the saddle bracket *h* and secured by a lock nut. The hood B fits over the eye A and is secured by the milled nut C. The bell hood D flanges into and depends from the plate *e* and is secured by the hood B whose lower edge passes over the upper edge of the bell hood D as clearly shown. The cover and hood can thus be firmly fixed or removed by hand without removing the conducting wires. The spring clips E for carrying the globe F are riveted to the bell hood D. The reflector or shade G is hooked over the lips of the globe F. A mica disk H protects the lower disk *f* and thus the working parts of the lamp from injury from the ascending gases from the arc. The current enters the lamp at I, thence through the series coil *m* to the holders of the upper carbons through the carbons tail rods and holders for the lower carbons to the terminal J. The shunt coil *o* is connected across the terminals I J in the usual manner. The friction grip devices of the two sets of carbons are arranged so that one set when the regulating levers *k* are actuated leaves the disk *e* before the other.

The operation of the duplex lamp is as follows: On the current passing to the lamp the regulating levers *k* raise the friction grip devices and the first to leave the plate *e* simply separates the corresponding carbons leaving the first pair of carbons—that is the pair to be first consumed—still in contact. On the further motion of the regulating lever the friction grip devices of the first pair of carbons leaves the disk *e*, separates the points of the carbons and strikes and maintains the arc. During the time that the first set of carbons are burning the grip of the second set of carbons keeps its grip on their cord and keeps the points apart. When the holders of the first set of carbons come to rest on the framework of the side rods *a c* and cannot feed further together the lever gradually lowers the

grip devices until the second device comes in contact with the disk and releases the second cord of the second set of carbons which then come in contact and the first set are immediately extinguished. The regulating levers *k* then again raise the grip devices and strike the arc for the second pair of carbons which continue to burn until completely consumed. In a similar manner a lamp with three or more pairs of carbons can be operated by a single striking and regulating mechanism.

As shown the upper or positive carbon is double the size of the lower or negative carbon so that the focus of the lamp is constant. In alternating current lamps the carbons may be of the same size.

What I claim, and desire to secure by Letters Patent, is—

1. In electric arc lamps in which the positive and negative holders are connected together by a cord passing over a pulley and in which the tendency of the carbon holders is to approach, the gravity friction grip device consisting of a system of links pivoted together to form a closed frame, of grip jaws between which passes the part of the cord or connecting device tending to move downward and which are attached to the jointed frame in such position that they approach one another as the frame elongates in a vertical direction, of a stop on which the lower end of the link frame rests and of a means for determining the position of the upper end of the frame relatively to the said stop according to the resistance of the lamp substantially as set forth.

2. In electric arc lamps in which the positive and negative holders are connected together by a cord passing over a pulley and in which the tendency of the carbon holders is to approach, the gravity friction grip device consisting of a lever mounted on the spindle of the loose cord pulley, of a means for determining the position of one end of the lever according to the resistance of the lamp, of a system of links suspended from the lever and pivoted together to form a closed frame, of grip jaws between which passes the part of the cord or connecting device tending to move downward and which are attached to the jointed frame in such position that they approach one another as the frame elongates in a vertical direction, and of a stop on which the lower end of the link frame rests substantially as set forth.

3. In electric arc lamps in which the positive and negative holders are connected together by a cord passing over a pulley and in which the tendency of the carbon holders is to approach, the arc striking and maintaining mechanism consisting of a lever mounted on the spindle of a loose cord pulley, of a solenoid core attached to the lever, of a corresponding solenoid arranged in series, of a system of links suspended from the lever in such manner that they are raised when a solenoid core is drawn into its coil and piv-



oted together to form a closed frame, of grip jaws between which passes the part of the cord or connecting device tending to move downward and which are attached to the jointed frame in such position that they approach one another as the frame elongates in a vertical direction and of a stop on which the lower end of the link frame rests, substantially as set forth.

10 4. In electric arc lamps in which each positive holder is connected to the corresponding negative holder by a cord passing over a pulley and in which the tendency of the carbons is to approach, a series of gravity friction grip devices one for each pair of carbons and each device consisting of a system of links pivoted together to form a closed frame, of grip jaws between which passes the part of

the cord or connecting device tending to move downward and which are attached to the jointed frame in such position that they approach one another as the frame elongates in a vertical direction, of a single stop on which the lower ends of the links rest, and of a means whereby the upper ends of the frames are raised together to a height dependent on the current through the lamp the said devices being so connected to the said means that they are successively raised off the said stop, substantially as set forth.

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

W. J. DAVY.

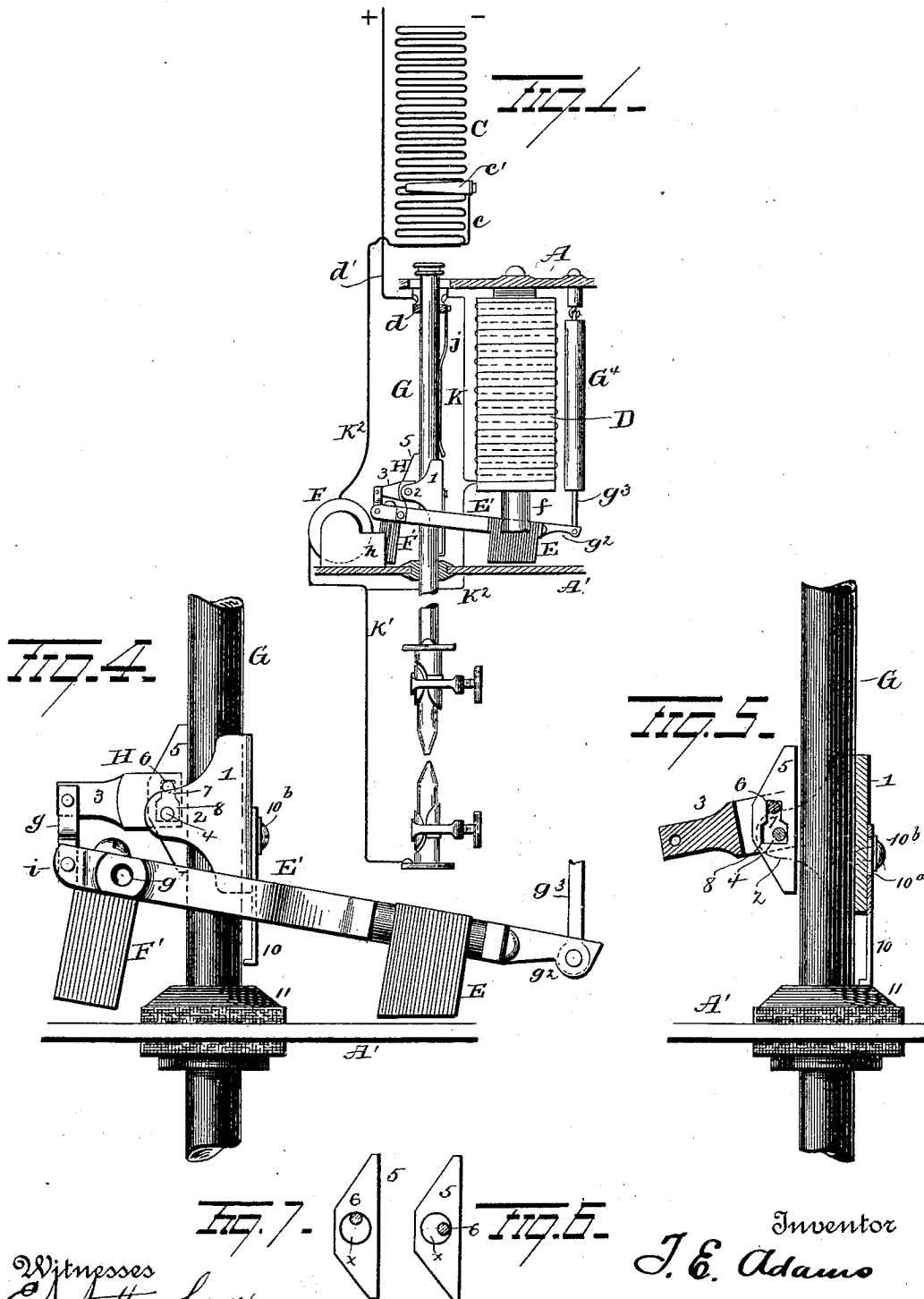
Witnesses:

GEO. J. B. FRANKLIN,  
WALTER J. SKERTEN.

T. E. ADAMS.  
ELECTRIC ARC LAMP.

No. 550,574.

Patented Dec. 3, 1895.



Witnesses  
*E. J. Atterbury*  
*G. J. Downing*

Inventor  
*J. E. Adams*  
 By *K. A. Seymour*  
 Attorney

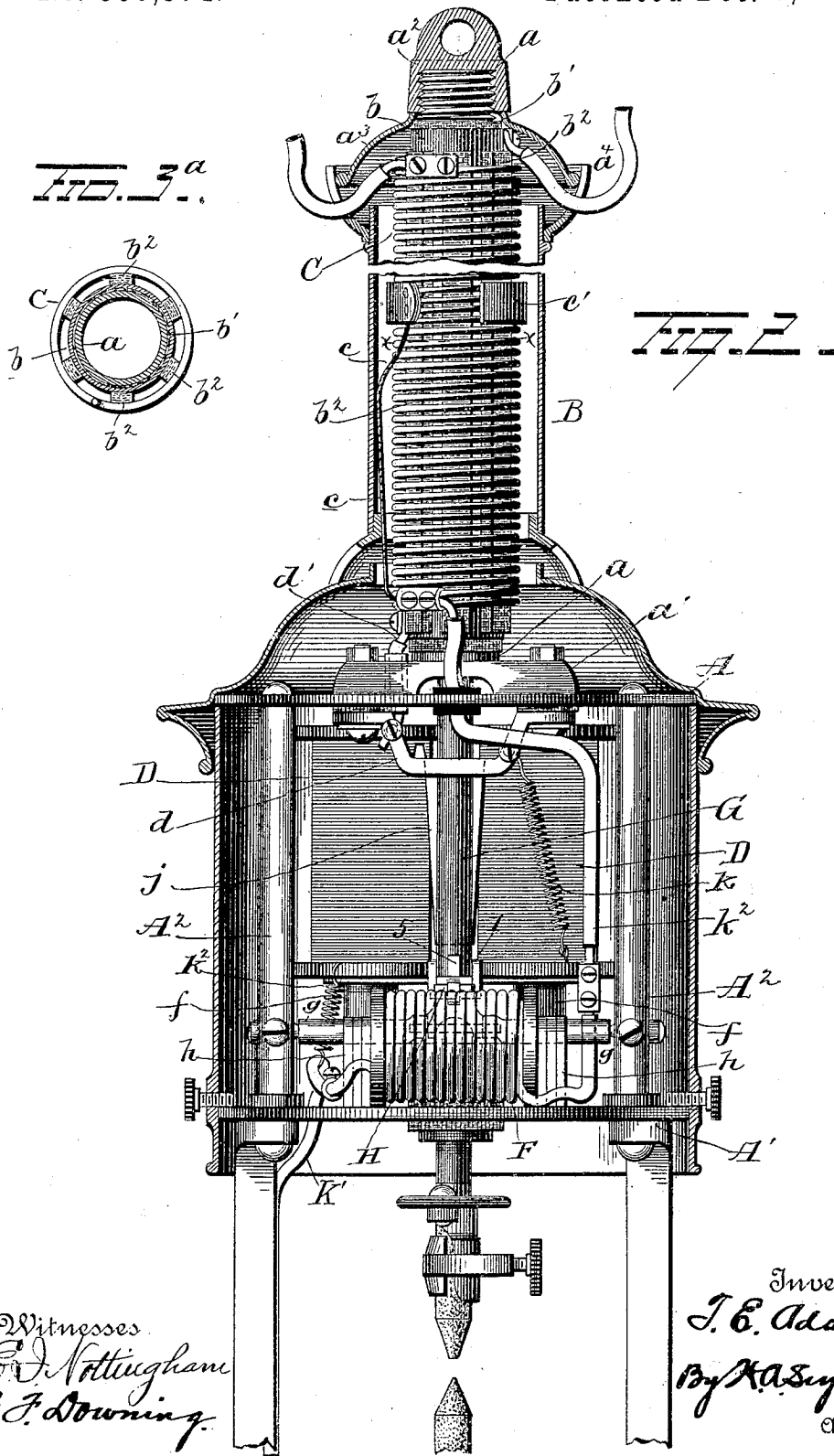
(No Model.)

3 Sheets—Sheet 2.

T. E. ADAMS.  
ELECTRIC ARC LAMP.

No. 550,574.

Patented Dec. 3, 1895.



Witnesses  
*E. D. Nottingham*  
*G. F. Downing*

Inventor  
*J. E. Adams*  
 By *K. A. Seymour*  
 Attorney

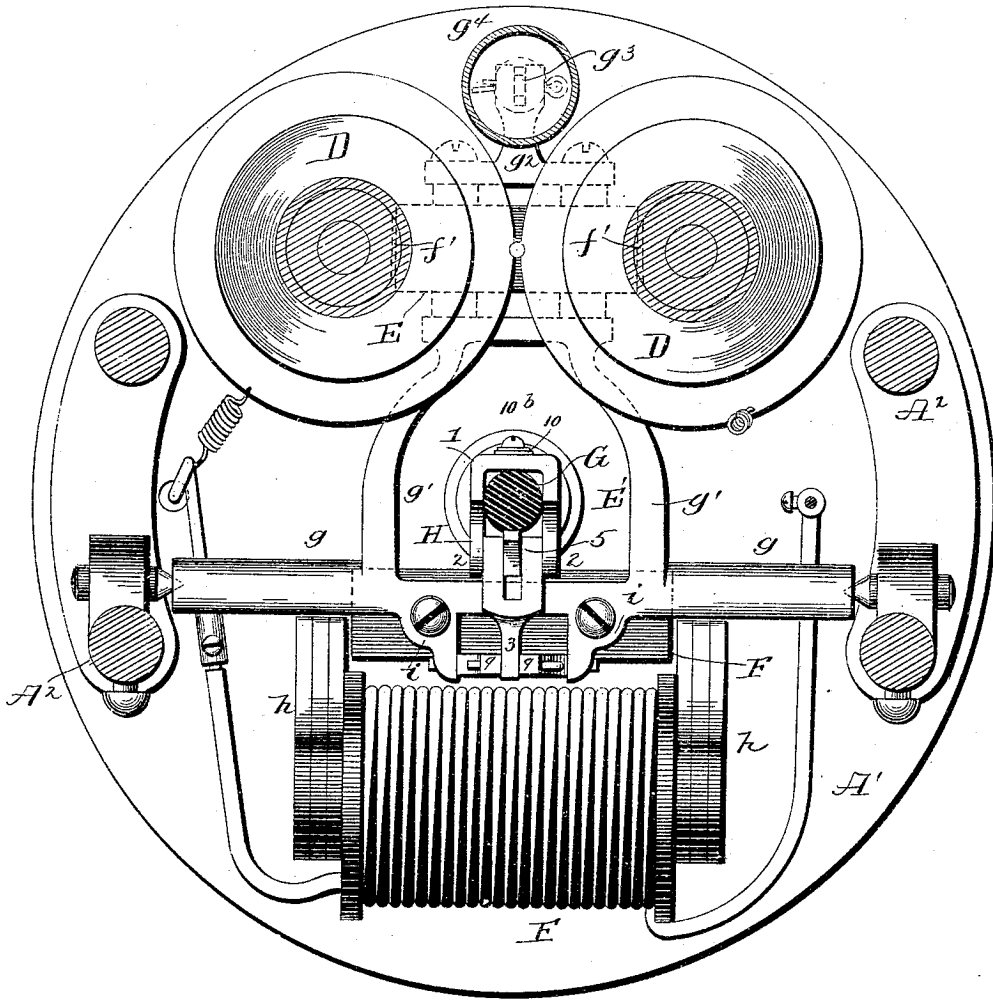
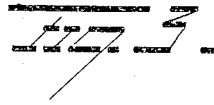
(No Model.)

3 Sheets—Sheet 3.

T. E. ADAMS.  
ELECTRIC ARC LAMP.

No. 550,574.

Patented Dec. 3, 1895.



Witnesses  
*C. Nottingham*  
*G. F. Downing*

Inventor  
*T. E. Adams*  
By *H. A. Seymour*  
Attorney

# UNITED STATES PATENT OFFICE.

THOMAS E. ADAMS, OF CLEVELAND, OHIO.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 550,574, dated December 3, 1895.

Application filed March 14, 1895. Serial No. 541,732. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS E. ADAMS, 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 designed more particularly for use on constant-potential circuits, one object of the invention being to so construct the lamp that its adjustments will remain certain and fixed more permanently than has been heretofore common in the art.

A further object is to produce devices so constructed and arranged as to prevent the "lapping" of the carbon points, which would produce a short circuit and result in either "blowing" the fuse on the line when such a large current is permitted to pass as would dangerously heat the conducting-wires or preventing the lamp from burning until the carbons are placed in proper alignment and the damage to the fuse or line repaired.

A further object is to so construct the friction-clutch which grasps the carbon rods that it shall have maximum durability.

A further object is to construct the clutch in such manner that its liability to be affected by dust and dirt will be reduced to a minimum.

A further object is to so construct the clutch of an electric-arc lamp that a carbon rod not perfectly smooth and true on its surface will be properly fed and so that it shall be convenient of adjustment in the lamp and compensate for wear of the carbon rod or other parts.

With these objects in view the invention consists in certain 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 a diagrammatical view illustrating my invention. Fig. 2 is an elevation. Fig. 3 is a horizontal sectional view. Fig. 3<sup>a</sup> is a section on the line *x x* of Fig. 2. Figs. 4, 5, 6, and 7 are detail views.

A A' represent the top and bottom plates

of the lamp-frame, connected together and properly spaced apart by means of standards A<sup>2</sup> A<sup>2</sup>, and B represents the chimney. A tube *a* is connected with a plate *a'*, secured to the top plate A of the lamp-frame and extends up through the chimney B. The upper end of the tube *a* is screw-threaded for the reception of a nut *a<sup>2</sup>*, below which a cap *a<sup>3</sup>* is located, said cap having a bearing on a ring *a<sup>4</sup>*, attached to the upper end of the chimney, and the ring *a<sup>4</sup>* is made with recesses for the positive and negative leading-in wires + and -.

A metallic tube *b* surrounds the tube *a* and is electrically separated therefrom by means of insulating material *b'*. A coil C, of German silver or other resistance material, is wound about the tube *b* and insulated from said tube by means of interposed strips *b<sup>2</sup>*, preferably of asbestos. The coil C is so wound that its convolutions will not be in contact with each other, and to the upper end of the coil the leading-in wire is connected. To the lower end of the resistance-coil a conductor *c* (composed, preferably, of strands of fine wire) is connected. The upper end of the conductor *c* is connected with a spring plate or adjuster *c'*, adapted to partially embrace the resistance-coil and have a "slide-wire" contact with the convolutions of the coil. By moving the plate or adjuster *c'* up or down the amount of resistance to be included in the lamp-circuit can be readily adjusted.

As shown in Fig. 2, the flexible conductor *c* can be made to move about the resistance-coil, so that when the contact-plate is moved up or down and partially rotated about the resistance-coil the slack in the conductor can be compensated for.

A metallic bracket *d* is secured to the under face of the top plate A of the lamp-frame and insulated therefrom, said bracket being electrically connected with the lower end of the metallic tube *b* by a short conductor *d'*, and to the upper end of said metallic tube the + leading-in wire is connected.

Fine-wire electromagnets D D are secured to the upper plate of the lamp-frame and depend therefrom. The poles *f* of the electromagnets D project some distance below the spools and are made with inner flattened faces *f'*, between which an armature E is disposed, said armature being preferably a rectangular

block of iron, which also constitutes a weight, for a purpose hereinafter explained. In other words, the electromagnets D are provided with a weighted armature.

5 The armature E is carried by an armature-lever E', which comprises a transverse shaft *g*, mounted at its ends in suitable lugs projecting from the standards A<sup>2</sup>, and arms *g'*, the armature being secured to the free ends  
10 of the latter. An arm or bracket *g*<sup>2</sup> is secured to the opposite side of the armature E, and to the free end of said arm the lower end of a plunger-rod *g*<sup>3</sup> is pivoted, the plunger connected with said rod operating in an air-pot  
15 *g*<sup>4</sup>, pivotally connected with the top plate A of the lamp-frame.

To the bottom plate A' of the lamp-frame and at the opposite side thereof from the fine-wire magnets D a coarse-wire magnet F is  
20 secured, the poles *h h* of said magnet F being located at the ends of the core and projecting forwardly from the spool. Between the poles *h h* an armature F' is disposed and secured to lugs *i*, projecting from the shaft *g* of the  
25 armature-lever, said lugs being located on the opposite side of the shaft from the arms *g'*.

The top and bottom plates A A' of the lamp-frame are perforated for the accommodation of the carbon or lamp rod G, said rod also  
30 passing through a perforation in the bracket *d* and into the tube *a*. A contact plate or brush *j* is secured to the plate or bracket *d* and bears at its free end against the carbon rod for conducting the current thereto. The  
35 plate or bracket *d* is also electrically connected with one end of one of the fine-wire coils by means of a spring or spiral conductor K, the free end of the other fine-wire coil being connected with a conductor K' by a short  
40 spring or spiral conductor K<sup>2</sup>. One end of the conductor K' is connected with the lower-carbon holder of the lamp and the other end is connected with one end of the coil of the coarse-wire magnet F, the other end of said  
45 coil being connected with the lower end of the resistance-coil C by a wire *k*<sup>2</sup>. Thus it will be seen that the coarse-wire magnet is included in the main circuit in series and the fine-wire magnets included in series with the  
50 coarse-wire magnet, but in a shunt-circuit around the arc.

In tracing the main circuit through the lamp it will be seen that the current enters at + and passes through the tube *b*, then through  
55 the conductor *d'* to the bracket *d*, then to the carbon or lamp rod G through the contact plate or brush *j*, thence through the upper carbon to the lower carbon, thence through the latter and its holder, and thence through  
60 the conductor K' to one end of the helix of the coarse-wire magnet. From the other end of said helix the current passes through wire *k*<sup>2</sup> to the resistance-coil C, then through the conductor *c* and plate *c'*, and then through  
65 more or less of the convolutions of said coil C, and finally out at -.

The path of the shunt-circuit will be traced

as follows: From the bracket *d* a portion of the current will pass through the spring or conductor K, then through the helices of the fine-wire magnets, and then by the conductor  
70 K<sup>2</sup> to the wire K', which latter is connected with one end of the helix of the coarse-wire magnet.

The carbon or lamp rod G passes through  
75 a clutch device H, the construction of which will now be explained. The saddle 1 of the clutch embraces the carbon rod G and is so constructed as to have an extended bearing  
80 thereon. From opposite sides of the saddle ears 2 project, between which the clutch-lever 3 is eccentrically pivoted by means of a pin 4, and at its pivoted end is bifurcated for the reception of a clutch-shoe 5, which is  
85 pivotally connected to said lever by means of a pin 6 passing through the contracted upper end of an angular or square-cornered slot 7, made in the shoe 5, the pin 4, which pivots the lever to the ears of the saddle, passing  
90 through the larger end 8 of said slot. Thus it will be seen that the shoe 5 will be permitted to move on its fulcrum a distance permitted by the width of the wider portion of the slot 7, which will be sufficient to cause the clutch to grasp or release the carbon rod.  
95 If a round pin 6 be passed through a round hole *x* in the shoe 5 of larger diameter than the pin, the normal position of rest will be as shown in Fig. 7, and when strain is applied the position of the pin in the slot would be  
100 as shown in Fig. 6. This change of position is lost motion, which is very undesirable in a clutch device for an electric-arc lamp. By making the portion of the slot 7 through  
105 which the pin 6 passes angular, as shown in Fig. 5, the position of the pin in the angular slot 7 will always be the same, either for position of rest or strain, and, again, by making the slot 7 in the manner above explained clogging by dust and dirt will be prevented.  
110 My improved clutch presenting such a long gripping-surface, a dent or enlargement on the lamp or carbon rod will not affect the proper operation of the clutch in the least. The free end of the clutch-lever 3 is pivotally  
115 connected to an arm 9, which latter is pivotally connected between the lugs or ears *i* on the shaft *g*, the clutch-lever thus being in effect connected with the armature-lever E'. To the saddle 1 of the clutch a trip-arm 10 is con-  
120 nected and adapted to engage the bottom plate A' of the lamp or a plate 11 secured thereto to release the clutch, as hereinafter explained, said trip-arm having an elongated slot 10<sup>a</sup> for the reception of a screw 10<sup>b</sup>, where-  
125 by to admit of the ready adjustment of said trip-arm.

In the diagrammatical view, Fig 1, the carbons are shown separated, as when the lamp is not burning. When the current is switched  
130 on, its only path will be through the fine-wire magnets, which at once draw up the weighted armature E, slowly lowering the clutch and carbon rod until the carbon points come into

contact. If the trimming of the lamp is regular the carbon points will come together before the clutch releases the carbon rod. Consequently the carbon cannot "lap," (a common trouble with constant-potential lamps.) The instant the points touch a path for the current will be closed through the helix of the coarse-wire magnet F, which latter will attract the armature F' (overcoming the pull of the fine-wire magnets E) and lift the clutch, which again separates the carbons and establishes the arc. The pull of the fine-wire magnets is nearly constant and the strength of the coarse-wire magnet varies with the resistance of the arc. As the carbons burn away, the resistance of the arc increases, and consequently the current flowing through the coarse-wire magnet decreases until the fine-wire or shunt magnets overcome its pull and slowly lower the carbon rod, thus maintaining the arc until the trip-arm 10 of the clutch reaches the plate 11 or the bottom plate A of the lamp-frame and releases the clutch. This allows the carbon rod to slide downwardly a little, but it will be instantly caught and raised by the clutch, because the approach of the carbons toward each other allows an increased current to pass through the coil of the coarse-wire magnet. When the carbons shall have been consumed, the circuit will be opened at the arc of the first pair of carbons (when several lamps are in the circuit) that can feed no more, and the carbons in another lamp that are not yet consumed will continue to touch and spark slightly, thus indicating that it is the dark lamp which needs trimming.

No harm will result if lamps are allowed to remain untrimmed and the only loss will be the slight current passing through the fine-wire coils until the current is opened at the switch. Experience has shown that no cut-out is needed, as the resistance of the fine-wire coils is sufficient to prevent burning out in case of accident to the carbons.

My improvements combine in the production of an electric-arc lamp which is simple in construction and effectual in all respects in the performance of its functions.

Various slight 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 restrict myself to the precise details of construction herein set forth; but,

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

1. In an electric arc lamp, a clutch comprising a saddle adapted to bear against the carbon rod and having ears projecting beyond the same, a bifurcated lever pivoted between said ears and a shoe pivoted in said lever and adapted to bear against the carbon rod, substantially as set forth.

2. In an electric arc lamp, a clutch comprising a saddle adapted to embrace the carbon rod, a clutch lever having a bifurcated

end pivotally connected to said saddle, a clutch shoe pivoted in said bifurcated end of the lever, said shoe having a slot made larger at one end than at the other, the pin which pivots the shoe to the lever passing through the smaller end of the slot and the pin which pivots the lever to the saddle passing through the larger end of the slot, substantially as set forth.

3. In an electric arc lamp, a clutch comprising a saddle adapted to embrace the carbon rod, a clutch lever eccentrically pivoted to said saddle, and a clutch shoe pivoted to said lever, substantially as set forth.

4. In an electric arc lamp, the combination with a carbon rod, an electro-magnet and an armature for said electro-magnet, of a clutch comprising a saddle adapted to embrace the carbon rod, a clutch lever eccentrically pivoted to the saddle, a connection between said clutch lever and said armature, and a clutch shoe pivoted to said clutch lever, substantially as set forth.

5. In an electric lamp, the combination with the chimney thereof of a metallic tube located therein and constituting a conductor, and a resistance coil inclosing said tube and insulated therefrom, substantially as set forth.

6. In an electric lamp the combination with a metallic tube, of a resistance coil inclosing the same and insulated therefrom, an elastic plate having a "slide wire" contact with said resistance coil, and a conductor for connecting said plate with one end of the resistance coil in such manner as to permit the elastic plate to be moved about said coil to take up slack of said conductor, substantially as set forth.

7. In an electric arc lamp the combination with a frame and a chimney, of a tube secured to the frame and extending through the chimney and having a screw threaded upper end, a flaring ring at the upper end of said chimney, a cap having a bearing in said ring and a nut on said screw threaded upper end of said tube bearing on said cap, substantially as set forth.

8. In an electric arc lamp, a clutch comprising a saddle adapted to embrace the carbon rod, a clutch lever having a bifurcated end pivotally connected to said saddle, a clutch shoe pivoted in said bifurcated end of the lever, said shoe having a square cornered slot made larger at one end than at the other, the pin which pivots the shoe to the lever passing through the smaller square cornered end of the slot and the pin which pivots the lever to the saddle passing through the larger end of the slot, substantially as set forth.

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

THOS. E. ADAMS.

Witnesses:

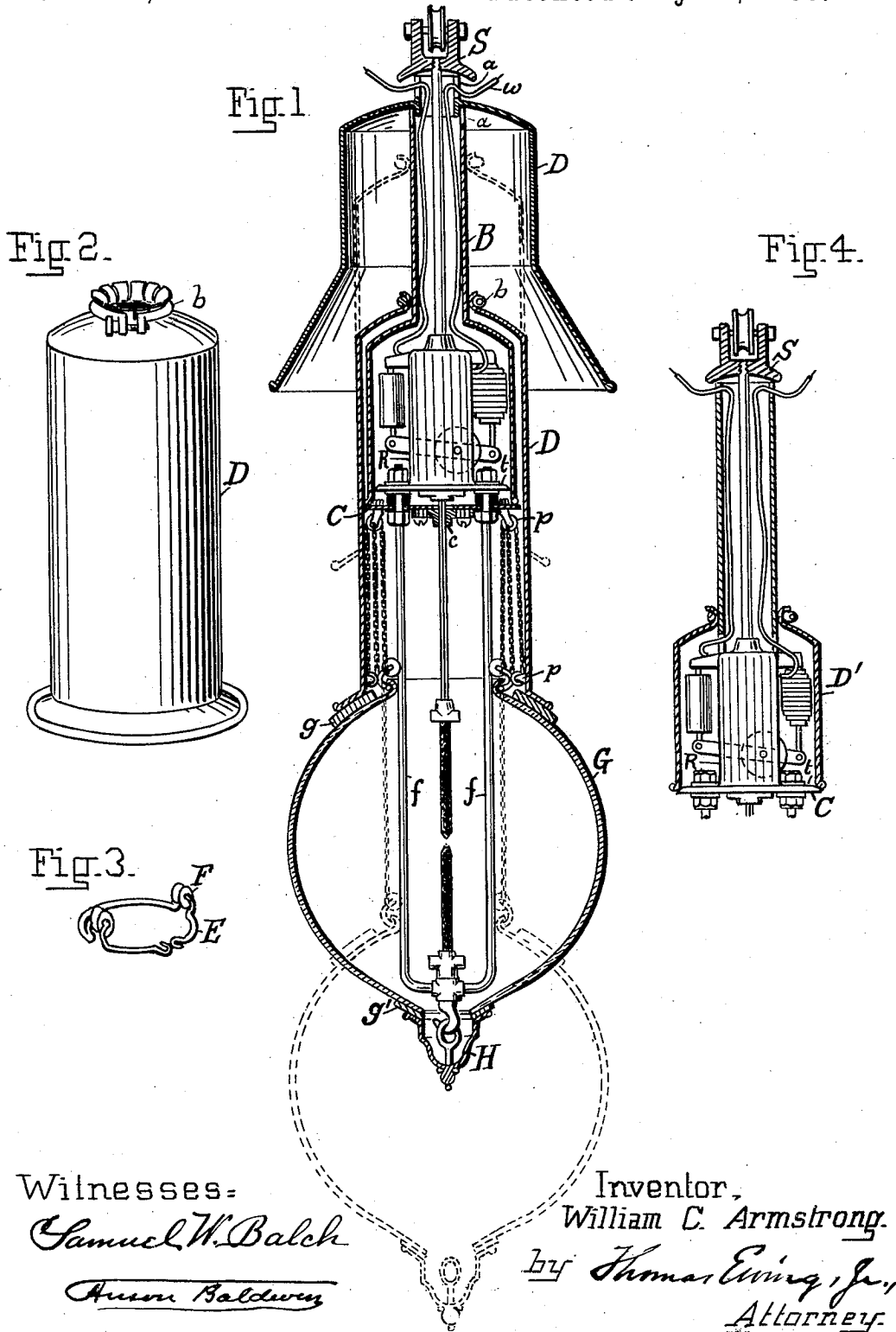
LEWIS H. ROGERS,  
A. D. DORMAN.

(No Model.)

W. C. ARMSTRONG.  
ELECTRIC ARC LAMP.

No. 564,771.

Patented July 28, 1896.



Witnesses:  
*Samuel W. Balch*  
*Amos Baldwin*

Inventor,  
*William C. Armstrong.*  
by *Thomas Ewing, Jr.,*  
*Attorney.*



# UNITED STATES PATENT OFFICE.

WILLIAM C. ARMSTRONG, OF NEW YORK, N. Y.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 564,771, dated July 28, 1896.

Application filed August 29, 1895. Serial No. 560,905. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM C. ARMSTRONG, a citizen of the United States of America, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Electric-Lamp Covers and Spark-Arresters, of which the following is a specification.

My invention is applicable to any style of lamp, but is particularly useful with alternating-current lamps, since the noise of these lamps is greater than of direct-current lamps. It is a combined spark-arrester, globe-support, and sliding cover, and is arranged to reduce the renewal of air within the lamp and to muffle the humming of the arc and the rattling of the parts. The construction is such as makes it possible to introduce damping-washers at all contacts where there is likely to be rattling.

The novelty as to the cover consists in a cover which incloses the body of the lamp and is open at its lower end to engage with and seal the upper or larger opening of the globe and is free to slide up and down along the stem above the works, which is usually called the "suspending-tube" or "chimney" of the lamp. The usual cover for the works of the lamp is extended downward below the base-plate of the works. The cover touches this base around its entire circumference. Below this upper base is a second base-plate or lower base, which is attached to the lower frame, which supports the lower carbon. This lower base is large enough to seal and extend slightly beyond the mouth of the inner cover, which it supports. Sparks or flame are thus prevented from getting within the cover to the works. The two bases are separated by insulating washers and bushing to form an air-space. Fumes getting inside the lower cover are dissipated in this air-space and do not reach the works.

The novelty in the globe-support consists in providing pulley-blocks and chains or equivalent mechanism for connecting the globe and outer cover in such manner that when the globe is pulled down the outer cover is pulled up. It also consists in a novel spring-clamp and guide for positioning the globe with respect to the lower frame.

In the accompanying sheet of drawings,

which form a part of this specification, Figure 1 is an elevation of an electric-arc lamp with the covers and globe shown in section in full lines in the positions in which they should be when the lamp is burning and in dotted lines in the positions occupied with the lamp open to give access to the carbons. Fig. 2 shows the sliding cover. Fig. 3 is a perspective view of the spring-clamp, which is the upper globe-holder and guide. Fig. 4 is an elevation of the upper part of a lamp with a modified form of cover, which is shown in section.

Referring now to Fig. 1, there is shown therein a lamp which may be of any desired construction. An inner cover or tube B, formed in one piece, incloses the works R and suspending-tube or chimney of the lamp. The tube part incloses the chimney, which in turn incloses the feed rod or rack of the upper carbon. Upon this tube the outer cover D is mounted, so that it can slide up and down along the tube, and hence along the chimney without touching the wires. This cover fits about the tube with a collar-band provided with a screw-clamp, (herein called the "clamping-collar" *b*.) The tube is notched, as shown at *a*, so that the wires can be led out from the lamp. The upper base fits closely within the lower end of this inner cover. An asbestos washer is applied between the inner cover and the lower base C. There is an air-space of about a quarter of an inch between these bases. On the bottom of each base is a guide *c* for the upper carbon-rod. The bolt-holes of the lower guide are larger than the diameter of the bolts, to allow for adjustment to secure alinement of the two guides.

The outer cover extends down around the inner cover and the upper end of the lower frame and is flared at its mouth where the face of the mouth rests upon the globe G, so as to encircle the large opening. This opening is large enough to admit of the lower frame *f f* projecting through it into the interior of the frame. The edge of the opening is flanged over to form a neck. A washer *g*, which is held between the cover and the globe, fits around this neck, and around it there is also hooked a bent wire E, which lies under the neck upon the outside of the globe at all points

except two diametrically opposite points where the wire is bent upward and inward to form springy inward projections upon which guide-rollers F are mounted. This device, which is illustrated in Fig. 3, I call a "spring-clamp." These guide-rollers are porcelain or rubber or other insulating material. This spring-clamp forms the upper globe-holder and guide and is sufficiently springy to dampen any vibrations and allow for expansion of the globe. It centers the globe around the lower frame while in the position of Fig. 1 and while being pushed up or pulled down. The insulating-rollers cut off outside metallic connections with the lower frame.

On the bottom of the lower base and on each side thereof is mounted a pulley-block *p*. At the lower edge of and inside the cover on each side is mounted another chain. Each pulley-block is attached at one end to the upper globe-holder and guide and thence carried over one of the pulley-wheels attached to the lower base, and thence around one of the pulley-wheels attached to the cover and thence up and attached at its other end to a becket on the pulley-block attached to the lower base. The cover is thus connected with the globe and frame of the lamp by chains and pulleys. When the globe is pulled down, it draws up the cover and the two take the position shown in Fig. 2. When the globe is pushed up to the position shown in Fig. 1, the cover D slides down by its own weight and closes the upper opening of the globe, thus sealing the lower frame of the lamp in the inclosed space formed by the globe and cover.

At the lower end of the lower frame is attached a lower globe-holding cap H, which is provided with an eye projecting upward within it. This eye is passed up through the small opening of the globe and engages with a hook *h* on the bottom of the lower frame and supports the globe. Between the globe-holding cap and the globe and encircling neck there shown, I may insert a washer *g'* similar to the one that lies between the outer cover and the globe except as to size. These washers are both preferably made of wool felting which is treated with a non-flammable substance. They may, however, be of cork, rubber, asbestos, or other suitable non-vibrating material which is non-flammable or rendered so.

When the globe is set in place and the globe-holding cap is hooked to the lower frame the outer cover is pressed down firmly upon the washer around the large opening and is clamped. The construction makes it possible to fit the cover to different sizes of globes. The outer cover, the globe, and globe-holding cap are all clamped together and lateral movement of the globe is prevented by the spring-clamp, which forms the upper globe-holder. As this spring-clamp bears against the lower frame the parts are securely held. All joints between the outer cover, globe-holding cap, globe, and frame, and between the inner cover

and lower base are sealed with non-vibrating cushions. Thus the ringing or other noises caused by vibrations at metallic contacts is cut off.

The entire works of the lamp are surrounded by air-spaces between the inner and outer covers and between the upper and lower bases. The entire lower frame is inclosed, partly by the outer cover, partly by the globe, and partly by the lower globe-holding cap. There is little opportunity for air to get in and out of the chamber occupied by the carbons. This increases the life of the carbons by diminishing the supply of oxygen. The conditions are also favorable to quietness in the lamp, because the noise can only be transmitted through the globe or through the walls of the outer cover or globe-holding cap, which are separated from the globe by collars, which dampen their vibration and the vibration of the globe.

Over the lamp, between the chimney and the hanger-nut S of the lamp, I attach a bell-shaped storm-cover A, opening downward and extending downward about to the line of the top of the feeding devices of the lamp. This storm-cover has a sleeve which is fitted into the top of the tube, which extends up from the inner cover and is held in place by the hanger-nut S, which is screwed down tightly upon it. This sleeve is notched at *a*, so that the wires can be led out from the lamp, as shown; but if desired the wires may instead be led through the notches in the top of the tube extending up from the inner cover. In this case they will come out under the storm-cover. The cast-iron hanger-nut may rest upon a rubber or asbestos washer and be provided with a roller of rubber instead of porcelain, and the lamp may be suspended by an asbestos rope. The humming is thus diminished.

Fig. 4 is added merely to show that the cover D need not seal the upper opening of the globe, but may merely cover the works of the lamp, as shown in this figure, the mouth of the cover resting upon the base on which the works are set. The cover of Fig. 4 is shaped like that shown in Fig. 2, except as to length, and is fitted with a clamping-collar around the chimney of the lamp, so that it can slide up and down along it, as described. This Fig. 4 is taken from my other application for an improvement in electric-lamp covers and spark-arresters, filed of even date herewith.

The lower part of the lamp is not shown in Fig. 4, as it has no bearing on the invention herein claimed.

Having now completely described my invention, without limiting myself to the precise details shown, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An electric-arc lamp, the works of which are provided with an outer and an inner cover and a chimney of reduced diameter, the outer

cover being fitted to slide up and down along the chimney of the lamp and to inclose the inner cover when the lamp is sealed, substantially as described.

5 2. An electric-arc lamp the works of which are provided with an outer and an inner cover, the inner cover being sealed with an upper and lower base, and the outer cover being fitted to slide up and down along the chimney of the lamp, substantially as described.

10 3. An electric-arc lamp provided with works, a chimney of reduced diameter located above the works, a globe, a cover fitted to slide up and down along the chimney, substantially as described.

15 4. An electric-arc lamp provided with works, a chimney of reduced diameter located above the works, a globe, a cover fitted to slide up and down along the chimney and to fit upon the globe around the upper opening thereof, substantially as described.

20 5. In an electric-arc lamp, the combination of the works a chimney of reduced diameter located above the works, a globe a cover which seals the upper opening of the globe and is free to slide up and down the chimney of the lamp, and a lower globe-holding cap to seal the lower opening of the globe substantially as described.

25 6. In an electric-arc lamp, the combination of the works, a chimney of reduced diameter located above the works, a globe, a cover which seals the upper opening of the globe, a lower globe-holding cap to seal the lower opening of the globe, and a clamping-collar on the cover, which surrounds the chimney, whereby the parts can be clamped together, substantially as described.

30 7. An electric-arc lamp provided with a globe, and a sliding cover connected to the globe by chains and pulleys, whereby the cover is pulled up as the globe is pulled down, substantially as described.

8. An electric-arc lamp provided with a globe, and a cover fitted to slide up and down the chimney and connected to the globe by chains and pulleys, whereby the cover is pulled up as the globe is pulled down, substantially as described.

9. In an electric-arc lamp a globe-holder consisting of a wire collar provided with projections carrying guide-surfaces, to form a spring-clamp and guides, substantially as described.

10. In an electric-arc lamp a globe-holder consisting of a wire collar provided with projections carrying insulating guide-rollers, to form a spring-clamp and guide, substantially as described.

11. In an electric-arc lamp, the combination of a lower frame, a globe covering the lower end thereof, an upper globe-holder consisting of a wire provided with projections carrying guide-surfaces to engage with the lower frame and forming a spring-clamp and guide, substantially as described.

12. In an electric-arc lamp, the combination of a lower frame, a globe covering the lower end thereof, a spring-clamp globe-holder carrying guide-surfaces to engage with the lower frames and covers sealing the openings of the globe, substantially as described.

13. In an electric-arc lamp the combination of the works, a cover inclosing them, and an upper and lower base for sealing the end of the cover, the cover fitting tightly over the upper base and resting upon the lower base, the two bases being separated by an air-space, substantially as described.

Signed by me in New York city this 12th day of August, 1895.

WILLIAM C. ARMSTRONG.

Witnesses:

SAMUEL W. BALCH,  
CHARLES KLAUSE.

(No Model.)

3 Sheets—Sheet 1.

# G. R. LEAN. ELECTRIC ARC LAMP.

No. 571,974.

Patented Nov. 24, 1896.

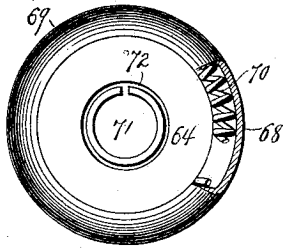


FIG. 2.

FIG. 3.

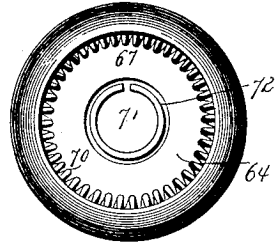
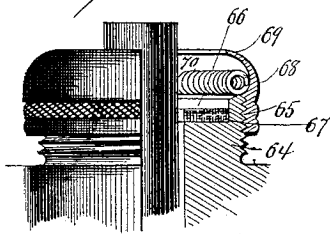


FIG. 4.

FIG. 5.

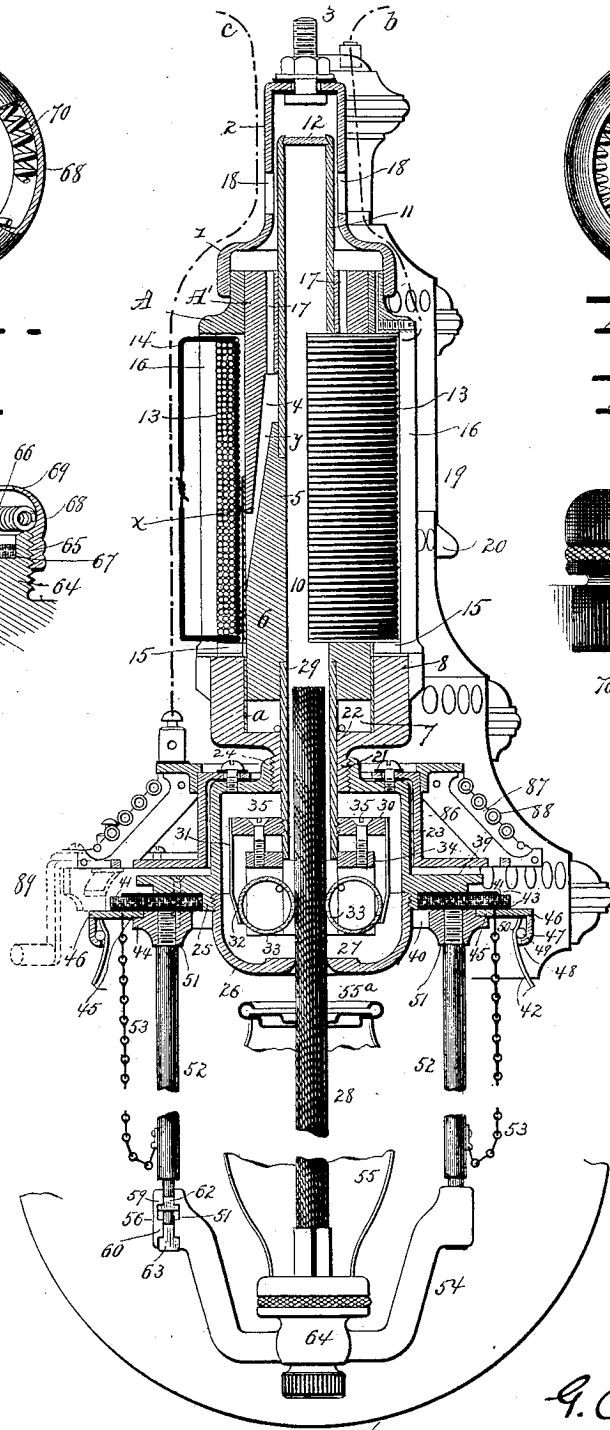
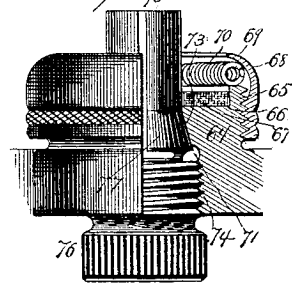


FIG. 1.

Witnesses  
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 Attorney

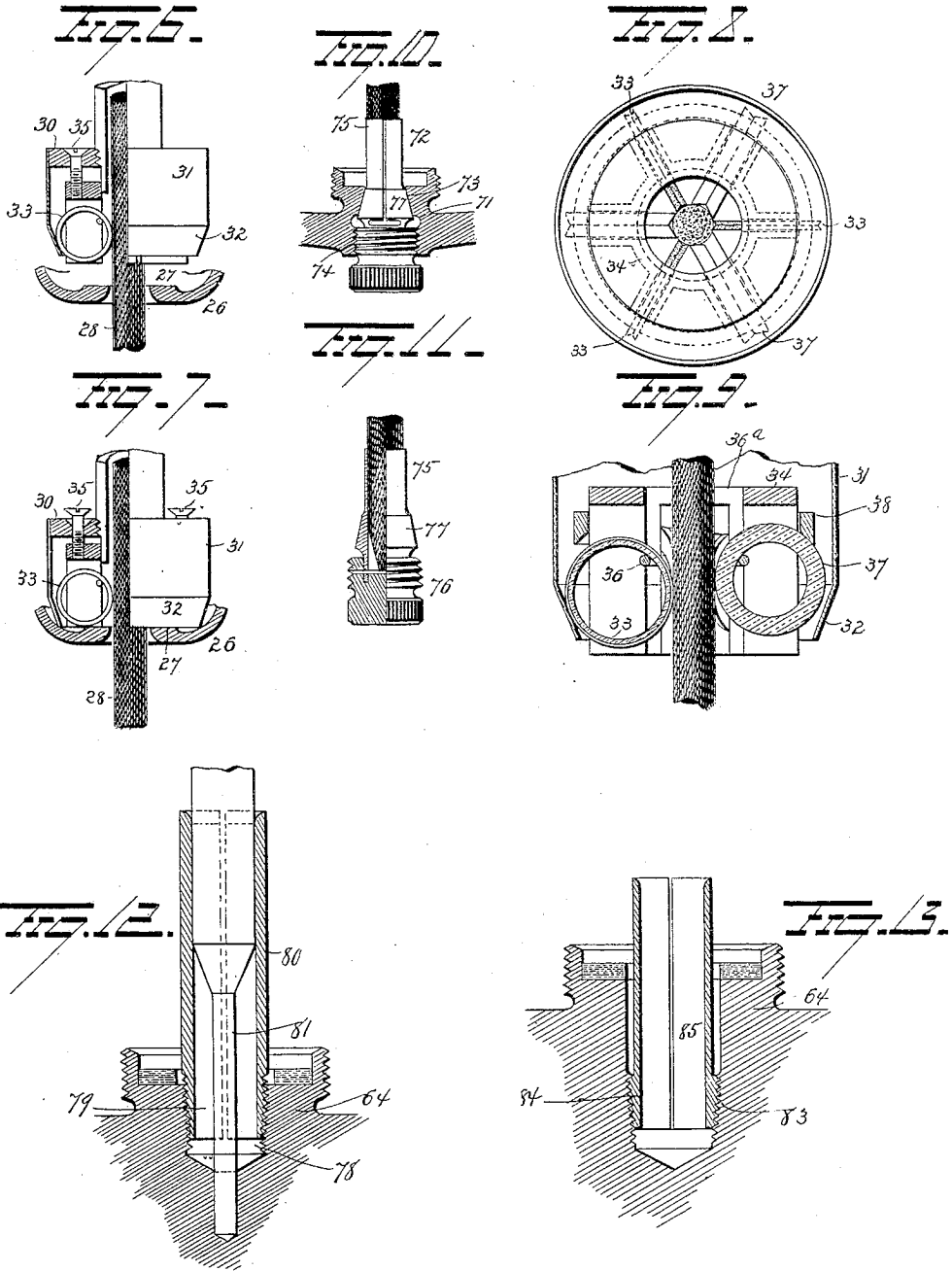
(No Model.)

3 Sheets—Sheet 2.

G. R. LEAN.  
ELECTRIC ARC LAMP.

No. 571,974.

Patented Nov. 24, 1896.



Witnesses  
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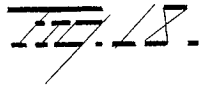
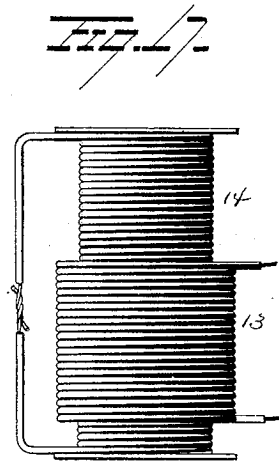
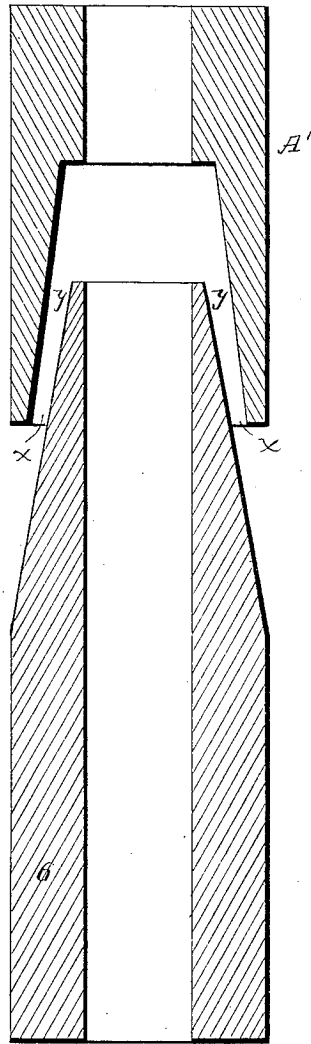
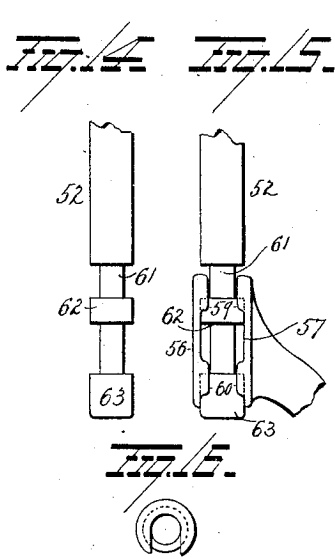
(No Model.)

3 Sheets—Sheet 3.

G. R. LEAN.  
ELECTRIC ARC LAMP.

No. 571,974

Patented Nov. 24, 1896.



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# UNITED STATES PATENT OFFICE.

GEORGE R. LEAN, OF CLEVELAND, OHIO, ASSIGNOR TO THE JANDUS  
ELECTRIC COMPANY, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 571,974, dated November 24, 1896.

Application filed May 23, 1896. Serial No. 592,787. (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, one object of the invention being to provide efficient means whereby to prevent the "pounding" of the lamps at starting through an excessive flow of current and to "steady" the arc when the lamp is burning, in case the voltage should suddenly rise or fall, without the necessity for the use of wasteful resistance in series with the lamp, which resistance as heretofore used in lamps in multiple-arc circuits has absorbed from twenty-five to forty per cent. of the energy.

A further object is to provide simple and efficient globe-holding devices for electric-arc lamps.

A further object is to provide a carbon-holder which shall be simple in construction, easy to manipulate, and which shall operate accurately to hold the carbon in proper position.

A further object is to provide simple and efficient means whereby to facilitate the trimming of the lamp.

A further object is to improve various features of construction of an electric-arc lamp and to so construct the lamp that it shall be accurate and noiseless in operation and effectual in all respects in the performance of its functions.

With these objects in view the invention consists in the combination, in an electric-arc lamp, of a separating and feeding magnet, a holder connected with the armature of said magnet, clutch-rings carried by said holder and adapted to engage the carbon, and contact devices also carried by said holder and adapted to bear continuously against the carbon for the purpose of conducting current thereto.

The invention also consists in a separating and feeding magnet for arc-lamps, having a conical core or pole-piece and a conical armature, one adapted to enter the other, and the

faces of the two cones arranged at an angle to each other; and the invention further consists in certain 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 a sectional view of an electric-arc lamp embodying my improvements. Figs. 2, 3, 4, and 5 are views illustrating the holder for the inner or arc-inclosing globe. Figs. 6, 7, 8, and 9 are detail views illustrating the combined clutch and contact devices. Figs. 10 and 11 are detail views of the lower-carbon holder. Figs. 12 and 13 are views illustrating modifications of the lower-carbon holder. Figs. 14, 15, and 16 are detail views illustrating the connections of the inner-globe and lower-carbon holder with the depending arms or uprights of the lamp. Fig. 17 is an enlarged view showing the closed coil and a portion of the primary winding for the separating and feeding magnet. Fig. 18 is an enlarged detail view of the core and armature of the magnet.

A represents the iron frame or shell of the feeding and separating magnet, to the upper end of which a cap or casting 1 is fixed and terminates in an upwardly-projecting hollow shank 2. An insulated screw 3 is secured to the upper end of the shank 2 for the attachment of a suitable device by means of which to suspend the lamp.

Within the shell A the core or pole-piece A' of the magnet is fixed and depends partially through the same, said core or pole-piece being made with a deep recess 4 in the form of a truncated cone for the reception of the similarly-shaped upper portion 5 of the armature 6 of said magnet. The core 6 is disposed within the shell A, and its lower end terminates within a chamber 7, formed by a cylindrical casting 8, of iron, fixed to the lower end of the shell A and forming, in effect, a part thereof. The chamber 7 is lined with sheet-brass or other suitable non-magnetic material a, and against this lining the armature 6 has a neat but sliding contact, said lining extending somewhat above the lower end of the core A' and inclosing the same. The cylinder or casting 8 thus constitutes a dash-pot for the armature 6 and in which said armature acts as a plunger. The armature 6 is made with

a longitudinal opening 10, in the upper end of which a tube 11 is secured, said tube extending up through the center of the core or pole-piece A' and terminating within the tubular shank 2 of casting 1, its upper end being closed air-tight by means of a cap 12. The helix 13 of the magnet is located within the shell, and also located within said shell is a closed coil or conductor 14. This closed coil may be placed within the helix 13, or it may be wound around it, or the magnet may be provided with sectional windings, one constituting the working helix and another forming the constantly-closed conductor. The armature of the magnet will be connected with the upper carbon of the lamp in a manner which will be hereinafter explained in detail.

With the constantly-closed coil or winding on the magnet, when the circuit is closed through the lamp, current will be induced momentarily in the closed or secondary winding in a reverse direction to the direction of current through the working or primary coil or helix. The current thus induced in the closed or secondary coil will tend to weaken the lifting-magnet and cause the arc to be drawn slowly, the secondary current becoming gradually weakened until it ceases altogether and the arc shall have been drawn to its full length. When the current is cut out of the lamp, there will be a secondary current induced in the closed or secondary coil in the same direction as the current through the working helix. This will increase, for an instant, the strength of the then-weakening magnet and thus cause the lamp to cease slowly instead of abruptly. These same actions will occur in a less degree with any change of voltage in the circuit or in case the arc should be momentarily interrupted from any cause, and thus maintain a constant and regular flow of current at the arc. The secondary circuit being only momentary does not affect the magnet nor the light of the lamp when the current is steady, but only when there is a fluctuation in the circuit, and thus has the advantage of steadying the arc and causing the lamp to burn very steadily without much external resistance, resulting in greatly increasing the efficiency of the lamp without loss through a resistance such as heretofore used.

By the use of the closed secondary winding arc-lamps can be burned on circuits of but little higher voltage than the voltage of the arc, instead of wasting a large amount of energy through a resistance, and greater steadiness in the burning of the lamp can be attained than is possible when such resistance is employed. The use of the closed secondary coil or winding enables lamps to be started and stopped smoothly without jumping and is particularly advantageous when a number of lamps are burned in series on high-potential circuits. The reactive effect produced by the closed secondary coil or winding can be used to advantage on the shunt-magnets of lamps

burning on constant-current circuits, the result being to prevent too sudden changes in strength of the shunt-magnet due to changes in the length of the arc or abnormal fluctuations in the current.

The core of the separating and feeding magnet and its armature comprises, as above mentioned, two cones, one adapted to enter the other. It will be observed that the wall of the conical recess 4 in the core of the magnet is not parallel with the conical face of the armature, but at an angle thereto. This is a matter of importance in adjusting lamps to operate under certain conditions. By changing the angle of the recessed cone to that of the entering cone the pull of the magnet can be changed to any desired range, so that when an arc is drawn too long the armature will be drawn into a weaker portion of the magnetic circuit and thus cause the arc to be corrected. By the arrangement of the cones above described the pull of the magnet can be made to remain constant throughout a predetermined range of movement of the armature by making the relative angles of the faces of the two cones such that the air-gap at the points  $x y$  will remain constant through this range. This can be accomplished by having the sum of the distance at the points  $x y$  average the same throughout the range, other fluctuations in the strength of the magnet, such as the magnetic gap at the entering-point of the armature, having been corrected. If the angle of the entering cone is less than the angle of the recessed cone, the pull of the magnet will constantly grow weaker as the armature is drawn into the recess, while the reverse of these angles will produce the opposite result. Thus it will be seen that by careful arrangement of the two cones a variety of results can be attained, such as a strong pull of the magnet for a portion of the range of movement of the armature and a gradual decline at the finish, or vice versa. I have found it to be of advantage in lamps burning in series on high-potential circuits to have the pull of the magnet constantly decreasing as the armature rises. This is exactly opposite to the pull of an ordinary solenoid as is commonly used in arc-lamps. I have found that for arc-lamps for use on one-hundred-and-ten-volt circuits it is of advantage to have the magnet produce a uniform pull on the armature throughout the ordinary lift of the carbon and from that point rapidly weaken, so that in case the lamp receives an abnormally high potential the armature will not rise in proportion to the increased voltage of the circuit and draw arc so long that it will break and cause the lamp to flicker. In this case the angles of the faces of the two cones would be such that a lamp burning at one hundred and ten volts would draw an eighty-volt arc, while the increase of ten per cent. in the potential of the lamp would not increase the arc over five per cent.

It is desirable to provide proper ventilation



for the windings 13 14, and for this purpose openings 15 are made in the armature-casing and through the lining *a*. For the same purpose the shell A is made with elongated slots 5 16 and the core or pole-piece is made with holes 17, which communicate at one end with the conical recess 4 and at the other end with the interior of the casting 1, the shank 2 of the latter being made with slots or openings 10 18. The sheet-metal casing 19, which incloses the operating mechanism of the lamp, is provided with air-vents 20. A free circulation of air will thus be permitted to keep the inside parts of the magnets and the windings cool 15 without allowing a current of air in the inclosed chamber 7, as the armature 6 constitutes a seal for said chamber below the openings 15.

An internally-screw-threaded collar 21 depends from the cylindrical casting 8 in line 20 with an opening 22 in the bottom of said casting. An annular box or casing 23, having an opening in its top, is disposed below the casting 8 and provided with an internally-screw-threaded collar 24 for the reception of the collar 21, depending from the casting 8. The box or casing 23 is provided at its bottom edge with an internally-screw-threaded annular flange 25 for the reception of screw-threads 30 on the periphery of a dish-shaped casting 26, which constitutes the bottom of said box or casing 23. The parts 23 and 26 thus constitute a receptacle or casing for inclosing the clutch and contact devices for the upper carbon, and the said casting or bottom 26 is provided centrally with a flattened enlargement 35 27, in which a hole is made for the passage of the upper carbon 28. A tube 29 is secured at its upper end to the lower end of the armature 6, so that its bore will align with the bore of said armature. The tube is adapted to loosely receive the upper carbon 28 and passes freely through the collar 21, terminating in the box or receptacle 23, preferably at or near its center, and carrying the clutch and contact devices for the upper carbon. In constructing these clutch and contact devices a horizontally-disposed plate 30 is secured to the tube 29 at a point near the lower end of the same, and from the periphery of this plate a circular casing 31 depends, the lower end of which is contracted or made with an inwardly-projecting flange 32, said casing forming an open-bottom clutch-pan, the rings 33, constituting said clutch, being adapted to rest on the inclined flange 32 of the clutch-pan and against the carbon-rod when the lamp is in operation, as shown in Figs. 1, 6, and 9. The clutch-rings 33 are made with roughened peripheral grooves whereby to cause them to properly engage the carbon-rod without danger of slipping, and said clutch-rings are disposed within a slotted carrier 34, supported from the plate 30 by means of screws 35, the upper ends of which pass loosely through said plate, and the carrier is provided in its top 65 with a hole 36<sup>a</sup> for the reception of the lower

extremity of the tube 29. In Fig. 8 of the drawings three clutch-rings are shown, and they are maintained in proper position by means of a horizontally-disposed ring 36 70 passing through them. A series of contact-rings 37, constituting the contact-brush for conducting current to the upper carbon, are mounted in the slotted carrier 34 and alternate with the clutch-rings 33, the horizontal ring 36 also passing through said contact-rings and serving to constantly support the same in contact with the carbon. The contact-rings 37 have smooth peripheral grooves 80 to conform to the contour of the carbon and are made equal in diameter to that of the clutch-rings, but with thicker or wider walls, so that they will be supported by the ring 36 somewhat higher than the clutch-rings. 85

When current is passing through the lamp, the position of the clutch devices will be as shown in Figs. 1, 6, and 9, the clutch-pan and slotted carrier being elevated above the bottom 26 of the casing which incloses them, 90 and the clutch-rings being clamped or wedged between the carbon-rod and the inclined flange 32. The rings 37 bear against the carbon-rod and are maintained in proper contact therewith by means of a weight 38, placed 95 upon them.

It is obvious that when the feeding of the upper carbon becomes necessary the clutch-pan and slotted carrier will move downwardly until the carrier engages the enlargement 27 of the casting 26, when it will be caused to move upwardly on the tube 29, as shown in Fig. 7. The clutch-rings will at the same time engage the enlargement 27 of casting 26 and be thus caused to rise slightly, 100 so as to loosen their grip on the carbon-rod and permit the latter to feed. The contact-rings 37, being more elevated in the carrier 34 than the clutch-rings 33, as above explained, they will not come in contact with the casting 26 when the clutch-pan and carrier are lowered, and hence the engagement of the contact-rings with the upper carbon will be constant under all conditions. 105

The box or casing 23, which incloses the clutch and contact devices, is made with a laterally-projecting annular flange 39, beneath which a ring 40 is disposed and insulated therefrom, a spring-cushion 41, for the outer globe 42, and sheets 43, of insulating 120 material, being located between said flange 39 and ring 40. The ring 40 is made with peripheral segmental flanges 44, adapted to receive and support similar segmental flanges 45, projecting inwardly from an annular plate or ring 46, the upper face of which has an air-tight bearing against the spring-cushion 41, or, more strictly speaking, against the lower insulating-sheet 43, on which said cushion rests. The plate or ring 46 is provided 125 with a depending peripheral flange 47, the lower edge of which is curved inwardly, as at 48, and forms a seat for packing-ring 49, on which the shoulder 50 at the upper edge of 130

the outer globe 42 rests, the extreme upper edge of said globe having a close fit against the under face of the annular plate or ring 46.

The ring 40 is made with internally-screw-threaded bosses or enlargements 51 for the reception of the screw-threaded upper ends of depending rods or uprights 52. Chains 53 are secured at one end to the annular plate or ring 46 and at their other ends to the rods or uprights 52 at points in proximity to the lower ends of the latter. When it is desired to remove the outer globe 42 for the purpose of trimming the lamp, it is simply necessary to give the globe a one-sixth turn, so as to bring the segmental flanges of the annular plate or ring 46 in line with the spaces between the segmental flanges 44 of the ring 40. The globe 42 can then be lowered and will be supported by the chains 53.

The rods 52 support at their lower ends a yoke or bracket 54, and the latter carries the holder for the inner or arc-inclosing globe 55 and the holder for the lower carbon of the lamp. In order that the arc-inclosing globe and the lower-carbon holder can be readily removed, the yoke or bracket 54, which carries them, is connected with the rods or uprights 52 in the following manner: Each end of the yoke or bracket 54 is made with a hollow boss or enlargement 56, open at one side, as at 57, and having an internal shoulder 58 at its upper end and lugs 59 60, projecting toward each other in the opening 57. The lower end of each rod or upright 52 is provided with a shank 61, having two enlargements 62 63, adapted to enter the hollow bosses 56 and be prevented from escape therefrom by the lugs 59 60, the enlargement 62 on the shank 61 being adapted to receive the shoulder 58 at the upper end of the boss. The yoke or bracket 54 is connected in the same manner to both rods or arms 52, except that the lateral opening 57 of one boss or enlargement 56 is at opposite side thereof from the lateral opening 57 of the other boss or enlargement. Thus it will be seen that by raising the yoke or bracket 54 and then turning it slightly it can be readily detached from the rods or standards 52.

The yoke or bracket 54 is provided centrally between its ends with a circular enlargement or base 64, having external screw-threads 65 and an annular recess 66, in which latter a packing-ring 67, of asbestos or other suitable material, is placed and adapted to receive the lower flanged edge of the inner or arc-inclosing globe 55, the latter being provided with a valved cover 55<sup>a</sup>, through which the upper carbon passes. A collar or cap 68 is adapted to screw on the enlargement or base 64, and is made with an inwardly-projecting curved flange or lip 69, within which and above the upper edge of the recessed portion of the enlargement or base 64 an annular coiled spring 70 is disposed. The lower flanged end of the inner globe 55 having been seated in the recessed base 64, the cap or col-

lar 68 will be screwed down until the annular coiled spring 70 holds the flange of the globe tightly against its seat in the base 64 of the holder, the spring being forced down toward said base as well as being contracted, as shown in Figs. 4 and 5. It is apparent that by unscrewing the cap or collar 68 the annular coiled spring 70 will be permitted to expand, as shown in Figs. 2 and 3, and thus permit the removal of the inner globe.

The base of the inner-globe holder is made with an opening 71 for the accommodation of the lower-carbon holder 72, the upper portion of said opening being made tapering, as at 73, and the lower portion 74 being made cylindrical and provided with screw-threads. The carbon-holder 72 comprises a split sleeve 75, of spring metal, to receive the lower carbon, and a nut 76, to which the lower end of said sleeve is secured. The nut 76 is adapted to screw into the lower portion 74 of the opening 71, and the sleeve 75 is made with a tapering enlargement 77, adapted to engage the tapering wall of the upper portion 73 of the opening 71. From this construction it will be seen that when the nut is screwed up the lower carbon will be tightly clamped within the split sleeve 75.

Instead of the construction of holder for the lower carbon above described, that shown in Fig. 12 might be employed. In this form the inner-globe holder is made with a tapering screw-threaded socket 78 for the reception of the tapering screw-threaded lower end 79 of the split sleeve or socket-piece 80. A post 81 is inserted in a socket in the base 64 and projects upwardly within the sleeve or socket-piece 80, terminating at its upper end in a head 82, which serves as a support for the lower carbon.

In the form of carbon-holder shown in Fig. 13 the base 64 is made with a deep socket 83, having a tapering screw-threaded portion at its lower end for the tapering screw-threaded portion 84 of the split sleeve or socket-piece 85, the diameter of the socket 83 above the screw-threaded portion being sufficiently greater than the external diameter of the sleeve or socket-piece 85 to permit the expansion of the latter for the insertion of the carbon. A recessed frame 86 encircles the box or casing 23 and is provided with strips 87 of mica, on which a wire of low resistance 88 is wound. The positive leading-in wire *b* of the lamp is connected with the magnet frame or shell, from which it passes to the clutch-pan and carrier and contact-rings to the upper carbon, then to the lower carbon, and then through the yoke or bracket 54 and rods 52 to the ring 40. The segmental flanges of the ring 40 being in electrical contact with the segmental flanges of the ring or plate 46, current will pass from the former to the latter and then through a switch 89, then through the low resistance 88, and finally out through the minus-wire *c*. Thus it will be seen that when the outer globe is lowered, as above ex-

plained, the circuit will be opened on account of the disengagement of the rings 40 and 46, and it will therefore be impossible for the trimmer to receive a shock while trimming the lamp, even though he should forget to turn the switch.

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.

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

1. In an arc-lamp, the combination with a magnet-core and armature, of a helix encircling said core and included in series with the carbons of the lamp, a constantly-closed conductor also encircling said core, whereby to effect the gradual starting and stopping of the lamp, and a clutch supported by said armature, substantially as set forth.

2. In an arc-lamp, the combination with the pole-piece of a magnet, an armature arc-starting mechanism and connections between the arc-starting mechanism and the magnet, of a helix encircling said pole-piece and armature and included in the lamp-circuit, and a constantly-closed conductor also encircling the pole-piece and armature, whereby to effect the gradual starting and stopping of the lamp, substantially as set forth.

3. A separating and feeding magnet for an electric-arc lamp having a conical pole-piece and a conical armature, the adjacent conical faces of said pole-piece and armature being disposed at an angle to each other, substantially as set forth.

4. A separating and feeding magnet for an electric-arc lamp having a conical pole-piece, and a conical armature, one adapted to enter the other and the faces of the two cones arranged at an angle to each other, substantially as set forth.

5. In an electric-arc lamp, the combination with suitable framework and a clutch, of a separating and feeding magnet having a conical recess in its pole-piece or core, an armature having a conical end to enter said conical recess, the conical face of the armature being disposed at an angle to the face of the conical recess in the pole-piece or core and connections between said armature and clutch, substantially as set forth.

6. In an arc-lamp, the combination with the separating and feeding magnet having a hollow core and a hollow armature, of a tube attached to and communicating with the armature and passing loosely through said hollow core, a tube depending from the armature and clutch devices connected with the last-mentioned tube, substantially as set forth.

7. In an electric-arc lamp, the combination with a magnet-shell, of a hollow cap or casting fixed to the upper end thereof, a pole-piece secured within said shell, a hollow armature also disposed within the shell and

constituting the plunger of a dash-pot formed at the lower end of the shell, a tube connected with the upper end of the armature and terminating within said hollow cap or casting, a cap closing the upper end of said tube, a tube depending from said armature, and clutch devices connected with said last-mentioned tube, substantially as set forth.

8. In an electric-arc lamp, the combination with a magnet-shell and a cylindrical casting secured within the lower end thereof, of a core depending within said shell, a helix within the shell, a lining in said cylindrical casting said lining inclosing the lower end of the core, an armature disposed within the shell and helix and having a sliding fit in the cylindrical casting, a tube depending from the armature and clutch devices carried by said tube, substantially as set forth.

9. In an arc-lamp, the combination with a carrier, of clutch-rings for the upper carbon, mounted therein, contact-rings also mounted in said carrier, and means for operating the clutch-rings without moving the contact-rings from the carbon, substantially as set forth.

10. In an arc-lamp, the combination with a clutch-pan and a carrier mounted therein, of a set of clutch-rings mounted in the carrier and adapted to engage the upper carbon, means for moving said clutch-rings to release the carbon, and contact-rings also mounted in said carrier and disposed in a higher plane than the clutch-rings so that they will not be affected by the operation of said clutch-rings, substantially as set forth.

11. In an arc-lamp, the combination with a slotted carrier adapted to permit the passage of the upper carbon through it, of a series of clutch-rings having roughened peripheral grooves, mounted in said carrier, a series of contact-rings mounted in said carrier and alternating with the clutch-rings, said contact-rings being of the same diameter as the clutch-rings but having thicker or wider walls and a supporting-ring passing through all of said clutch and contact rings, substantially as set forth.

12. In an arc-lamp, the combination with the armature of the separating and feeding magnet, of a clutch pan or receptacle connected therewith, a vertically-movable slotted carrier supported in said pan or receptacle, clutch-rings mounted in said carrier, a horizontal ring passing through said clutch-rings, and a device adapted to be engaged by said carrier and clutch-rings, whereby to cause them to move upwardly and the carbon to feed, substantially as set forth.

13. In an arc-lamp, the combination with the separating and feeding magnet and its armature, of a tube depending from said armature, a plate secured to said tube near its lower end, a casing depending from said plate and having an inclined flange at its lower end, a vertically-movable carrier within said casing and having a hole to receive the lower

end of said tube, clutch-rings mounted on said carrier and adapted to bear against said inclined flange and the carbon-rod, a horizontal ring passing through the clutch-rings, and a device to be engaged by said clutch-rings and carrier, substantially as set forth.

14. In an arc-lamp, the combination with a magnet-shell, a cylindrical casting secured thereto and an armature within said shell, of a box or casing secured to said cylindrical casting, a removable bottom for said box or casing and having an opening for the passage of the carbon, a tube secured to the armature and passing into said box or casing, a clutch-pan secured to said tube, a carrier in said clutch-pan, clutch-rings in said carrier and pan and adapted to engage the bottom of the box or casing to permit the carbon to feed, and a horizontal ring passing through said clutch-rings, substantially as set forth.

15. In an arc-lamp, the combination with the framework, of a ring removably attached to said framework, having a flange adapted to receive and support a globe and a cushion against which said ring bears, substantially as set forth.

16. In an arc-lamp the combination with the framework of a ring supported thereby, a spring-cushion above said ring, an annular plate adapted to be removably secured to said ring and bear against said spring-cushion, a curved flange depending from said annular plate, a globe, and a packing-ring between the peripheral flange of the globe and said curved flange on the annular plate, substantially as set forth.

17. In an arc-lamp, the combination with the framework, of a ring secured thereto and insulated therefrom, a globe-holder removably connected with said ring, a lower-carbon holder, electrical connections between said carbon-holder and said ring, said ring and globe-holder constituting part of the circuit through the lamp, so that when the globe and its holder are removed, the lamp will be open-circuited, substantially as set forth.

18. In an arc-lamp, the combination with the framework, and an insulated ring supported thereby, of rods depending from said ring, a yoke or bracket removably secured to the lower ends of said rods, and an inner-globe holder and lower-carbon holder supported by said yoke or bracket, substantially as set forth.

19. In an arc-lamp, the combination with the framework, of two depending rods supported thereby and insulated therefrom, buttons or enlargements on the lower ends of said rods, a yoke or bracket, hollow bosses at the ends of said yoke or bracket, lugs projecting into said openings, and internal shoulders at the upper ends of said bosses for the reception of the buttons or enlargements on the depending rods, substantially as set forth.

20. A globe-holder comprising a base, an adjustable cap thereon and a spring-ring within said cap and adapted to be forced against the

flange of the globe by said cap, substantially as set forth.

21. A globe-holder comprising a base, an adjustable cap thereon, and an annular coiled spring adapted to be forced by said cap, against the flange of the globe whereby to force the latter against its seat, substantially as set forth.

22. A globe-holder comprising a base, an adjustable cap thereon, said cap having an inwardly-curved flange, and an elastic ring adapted to be forced against the flange or shoulder on the globe by said curved flange on the cap, substantially as set forth.

23. A globe-holder comprising a base having external screw-threads, a cap adapted to screw on said base, said cap having an inwardly-curved annular flange at its upper edge, and an annular coiled spring within said curved annular flange, substantially as set forth.

24. A globe-holder comprising a recessed base, a packing-disk thereon, a screw-cap on said base, said cap having a curved flange at its edge, and an elastic ring adapted to be pressed against the shoulder on the globe whereby to force the edge of the globe against said packing-disk, substantially as set forth.

25. In an arc-lamp, the combination with a base having an externally-screw-threaded projection and having a hole, a portion of said hole being made with a tapering wall and a portion being made with a screw-threaded wall, of a cap adapted to screw on the screw-threaded projection, a device within said cap adapted to be forced by the cap against the flange of a globe whereby to clamp the latter to the base, and a split sleeve passing through the hole in the base and adapted to receive a carbon, said sleeve having a tapering portion to bear against the tapering wall of the hole in the base and a nut to screw in the screw-threaded portion of said hole in the base, substantially as set forth.

26. The combination in an arc-lamp, of a separating and feeding magnet and the carbons, a frame, strips of insulating material supported by said frame, and a low resistance wound on said bridges and included in circuit with the separating and feeding magnet and the carbons, substantially as set forth.

27. In an arc-lamp, the combination with the framework and a low resistance, of an insulated ring supported by the framework, a globe-holder removably attached to said ring, a lower-carbon holder included in circuit with the said ring and globe-holder, and a switch between said globe-holder and resistance, substantially as set forth.

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

GEORGE R. LEAN.

Witnesses:

D. W. ROCKWELL,  
J. M. SEE.

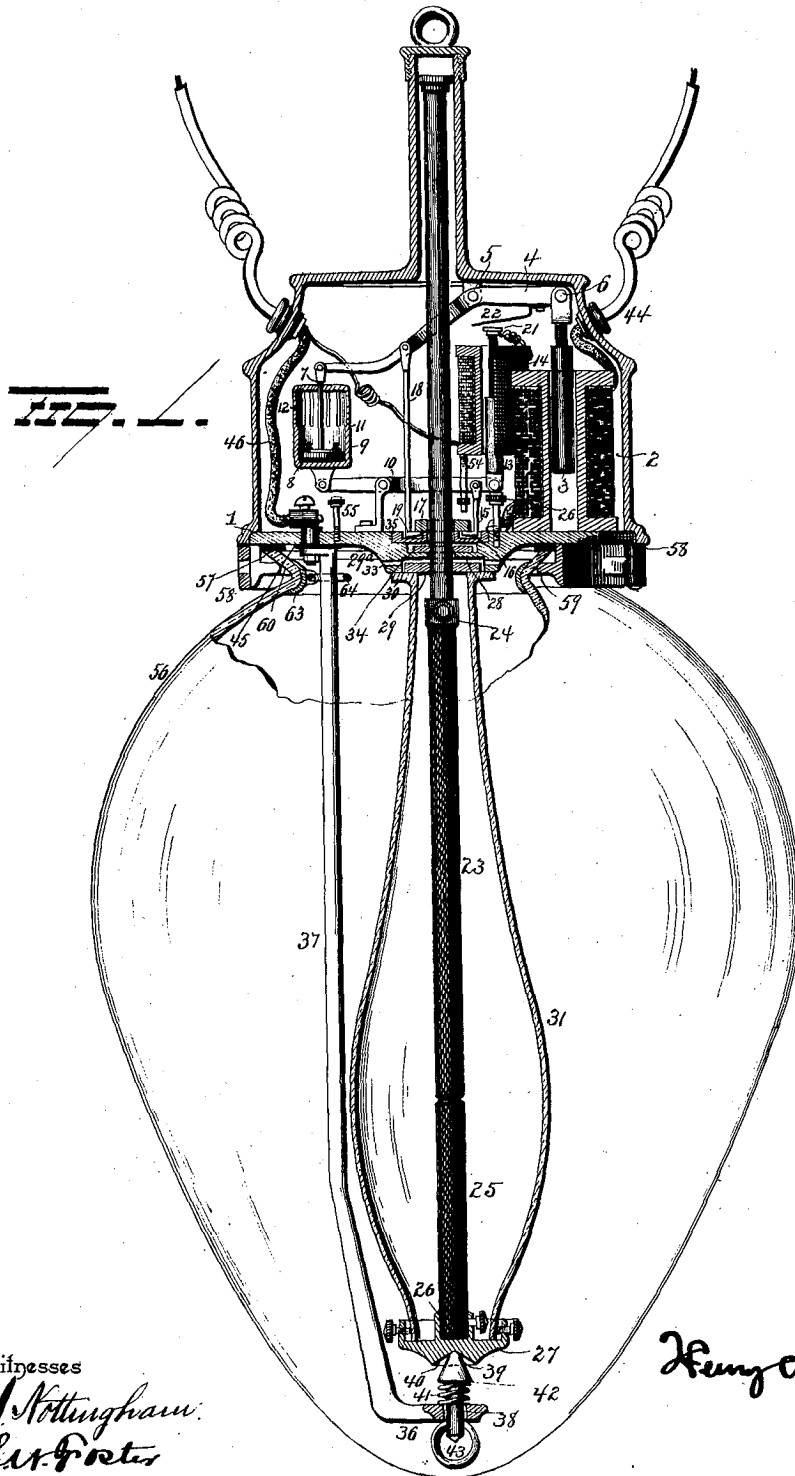
(No Model.)

3 Sheets—Sheet 1.

H. A. SEYMOUR.  
ELECTRIC ARC LAMP.

No. 574,118.

Patented Dec. 29, 1896.



Witnesses  
*E. J. Nottingham*  
*S. J. Foster*

Inventor  
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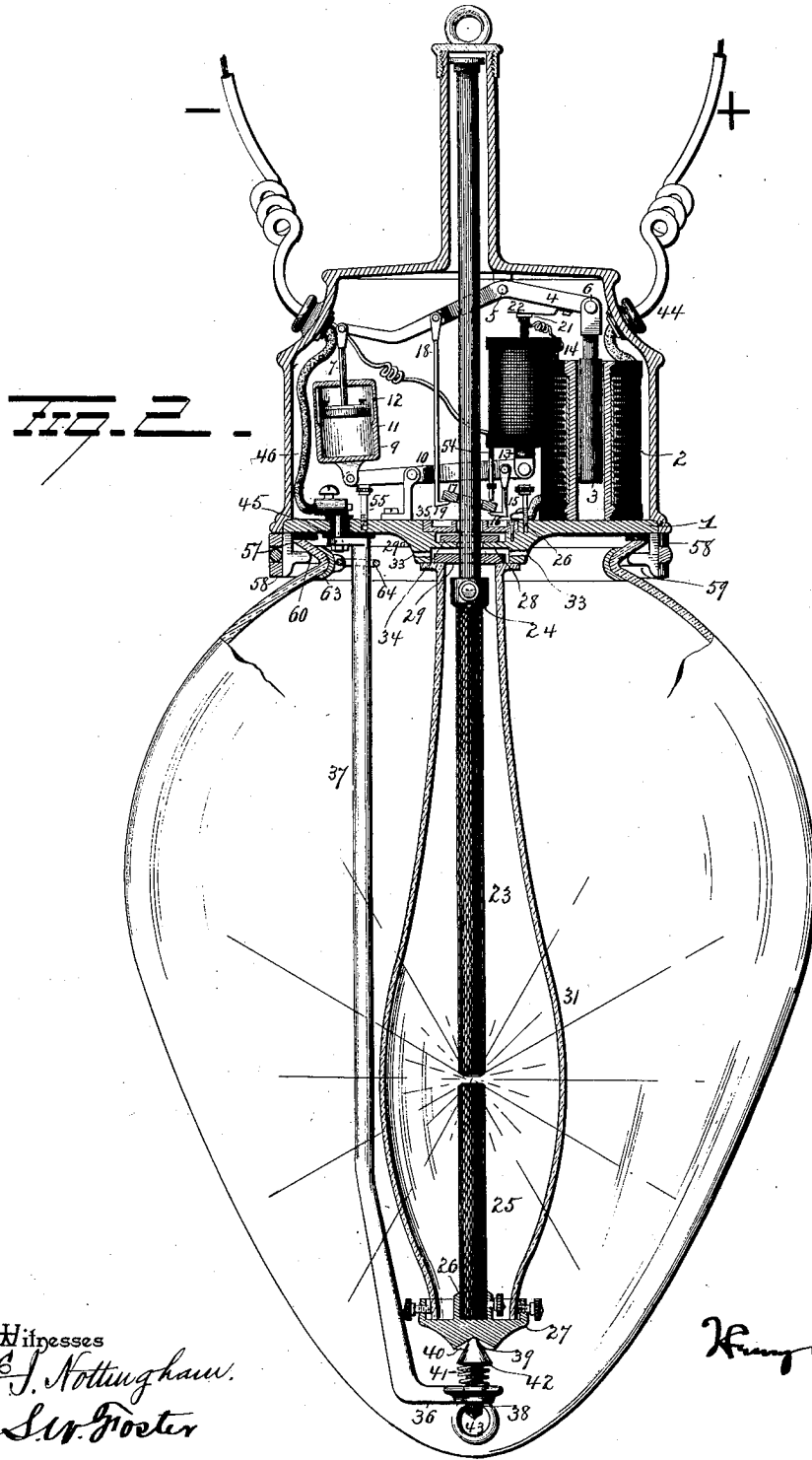
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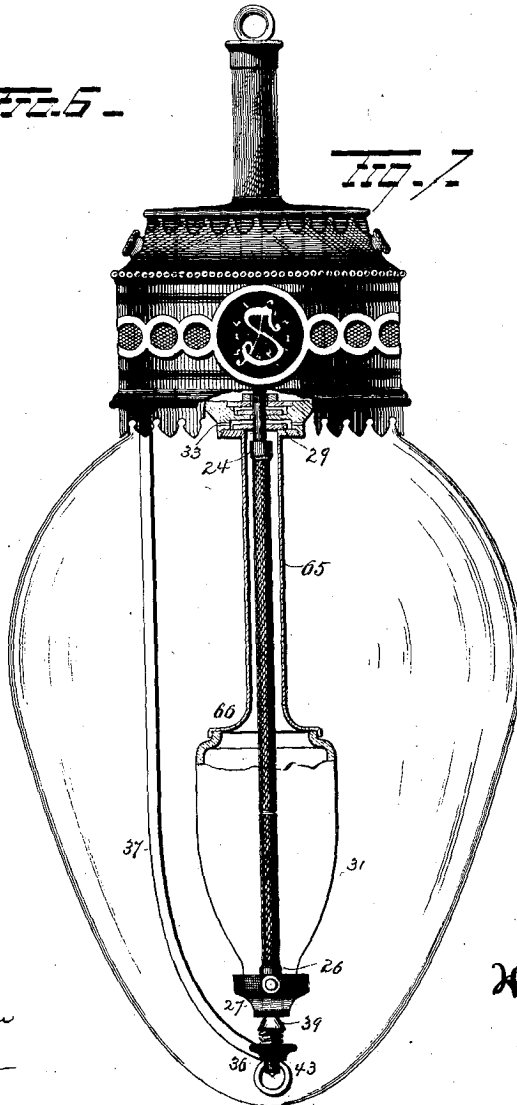
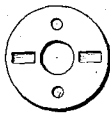
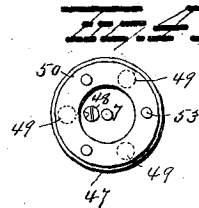
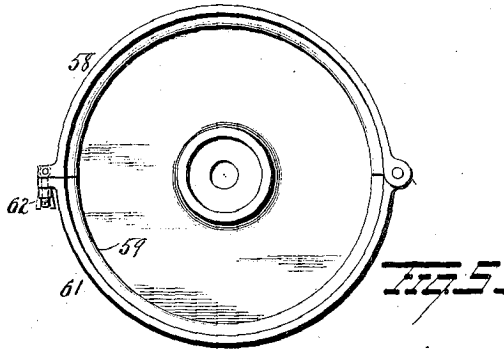
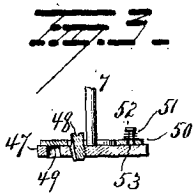
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H. A. Seymour.

# UNITED STATES PATENT OFFICE.

HENRY A. SEYMOUR, OF WASHINGTON, DISTRICT OF COLUMBIA.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 574,118, dated December 29, 1896.

Application filed July 11, 1896. Serial No. 598,879. (No model.)

*To all whom it may concern:*

Be it known that I, HENRY A. SEYMOUR, a resident of Washington, in the District of Columbia, have invented certain new and useful Improvements in 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 arc-lamps, and especially to that type of lamps which employ an arc-inclosing globe.

Inclosed arc-lamps are ordinarily constructed for use on constant-potential circuits, and their economical operation requires that a long arc be established and maintained between their carbons. While arc-lamps of this type have been constructed for use with a straight current, no one, so far as I am aware, has succeeded as yet in producing a lamp of this type which is adapted to be satisfactorily operated by an alternating current. The following are among the obstacles that have been encountered in the attempts that have been made to provide a successfully operative alternating-current arc-lamp of the type in question.

The establishment of an arc between the cold carbons of a lamp is effected by heating their adjacent ends to such a degree as will insure the production of a conducting-bridge of incandescent carbon vapor across the gap or space between them, over which the current may flow continuously until an arc of normal length has been established; but the establishment of an arc between the cold carbons of an alternating lamp has been attended by a violent chattering of the carbons and regulating mechanism, which has been due to the excessively rapid rise and fall of the current, causing the magnets of the lamp to be energized and deenergized in such rapid succession as to prevent the heating of the ends of the carbons to a sufficient degree to preserve the integrity of the circuit through them until quite a time has elapsed after the current has been switched through the lamp. Attempts have been made to obviate this trouble by so retarding the separation of the carbons as to insure of their being heated and gradually separated without interrupting the circuit between them; but such means ren-

dered the action of the regulating mechanism so slow and sluggish in adjusting and feeding the carbons that the arc was frequently extinguished, and it was found impossible to maintain a long arc in continuous operation. Again, arc-inclosed lamps as ordinarily constructed have been provided with a small arc-inclosing globe having a cover through which the carbon is fed into the globe. In some constructions the opening through the cover has been so formed as to produce a gas-check around the carbon and thereby lessen the ingress of outer air to the interior of the globe. In others an annular valve has been seated upon the cover and arranged to encircle the carbon, while in other constructions provision has been made for permitting of the lateral adjustment of the globe to allow it to accommodate itself to the carbons; but all of these constructions, in which attempts have been made to pack the carbon, have proved objectionable, owing to the impossibility of preserving an air-tight joint between the carbon and the opening through which it is fed into the globe. This has been due to the fact that in the manufacture of carbons it has been found impossible to make them absolutely true and straight and with a perfectly smooth and regular outer surface. Hence to insure the free adjustment and feed of the carbons it is necessary to provide considerable play or space between them and the opening through which they are fed into the globe, in order to provide for such irregularities in their form and surface.

The object of my invention is to obviate the defects and difficulties above referred to and provide an arc-lamp adapted to be operated by an alternating current and so constructed that when switched into circuit its carbons will be separated so slowly and gradually that an arc of any desired length may be drawn between them without the chattering of the carbons or regulating mechanism, and upon the production of an arc of the desired length the regulating mechanism will be instantly released from its retarding mechanism and caused to sensitively feed the feeding carbon without materially varying the length of the arc or the steadiness of the light produced by it.

A further object is to provide an arc-in-



closed lamp of such construction that all packing about the carbons is dispensed with and the arc-inclosing globe maintained practically air-tight by packing applied to the carbon-holder.

5 With these ends in view my invention consists in features of construction and combinations of parts, as will be hereinafter more fully described, and pointed out in the claims.  
 10 In the accompanying drawings, Figure 1 is a view, partly in vertical section and partly in side elevation, of an arc-lamp embodying the invention. Fig. 2 is a similar view representing the position of the parts when the  
 15 lamp is in operation. Figs. 3 and 4 are detached views of the dash-pot. Fig. 5 is a detached view of the clamp for supporting the outer globe. Fig. 6 is a detached view of the detachable clutch-floor, and Fig. 7 is a modification.

20 1 represents the lamp-floor; 2, a coarse-wire solenoid; 3, the core of the solenoid; 4, a lever pivoted at 5 and to which the core is pivotally connected at 6. To the opposite end of the  
 25 lever is pivotally connected the piston-rod 7 of the dash-pot 8, the cylinder 9 of which is pivoted to one end of a lever 10. The bore of cylinder 9 is made smooth from its bottom up to the point 11, and from thence to its top it  
 30 is formed with open grooves 12. Piston 47 of the dash-pot snugly fits within the lower portion of the cylinder and is provided with an adjustable screw-valve 48, by which its  
 35 movement may be regulated. Any desired number of passages 49 extend through the piston and are covered by an annular valve 50, seated on the upper side of the piston and retained against its seat by spiral springs 51,  
 40 which rest at their lower ends against the valve and at their upper ends against the heads 52 on the guide-pins 53, which pass through the piston. By means of this construction of piston its upward movement may be retarded and checked to any desired extent by varying the adjustment of the screw-valve, while the yielding annular valve allows of its quick and prompt downward movement.

45 The core 13 of a high-resistance shunt-solenoid 14 is pivoted to one end of the lever  
 50 10. Depending from one end of lever 10 is a rod 15, provided with a lateral projection 16 at its lower end, which enters a recess in the lamp-floor and projects beneath one edge of the ring-clamp 17. The projection 16 is, in  
 55 effect, an adjustable floor for the ring-clamp. Lifter 18 is pivotally connected at its upper end to lever 4, while its lower end is formed with a finger 19, which enters a recess in the lamp-floor and projects beneath the edge of  
 60 the ring-clamp at a point opposite the adjustable support or floor 16. An adjustable stop 20, attached to the floor of the lamp, projects beneath one end of lever 10 and serves to limit the upward movement of the cylinder  
 65 of the dash-pot.

21 is an insulated contact block or strip which is electrically connected with one end

of the helix of the shunt-solenoid, the opposite end of which is connected with the negative binding-post of the lamp. A spring-contact 22 is connected with lever 4 and is arranged so as to engage the contact 21 when lever 4 is drawn down by the coarse-wire solenoid.

70 The feeding carbon 23 is secured within the socket 24, attached to the carbon-holder, while the non-feeding carbon 25 is fastened in the socket 26, formed on the plate 27. The under side of the lamp-floor is countersunk around the opening 28, through which the carbon-  
 80 holder passes. Within the countersunk opening is placed an annular valve 29, which is seated upon the flanged upper end 30 of the arc-inclosing globe 31. The upper end of the arc-inclosing globe is formed with a ground  
 85 or perfectly flat surface which seats against the annular seat 32 on the under side of the lamp-floor and forms practically an air-tight joint therewith. Annular valve 29 snugly fits the smooth cylindrical carbon-holder and  
 90 forms practically an air-tight joint therewith.

Any desired number of passages 33 are provided in the lamp-floor, through which any gases that may escape from the arc-inclosing globe will flow into the outer globe.

95 34 is an annular valve which encircles the carbon-holder and serves to prevent the escape of gases from the arc-inclosing globe into the casing containing the regulating mechanism.

100 A detachable clutch-floor 35 (shown in detail in Fig. 6) is fitted within a recess formed in the upper side of the lamp-floor and is secured against rotary displacement by means of screws or other means. The lower end of  
 105 the arc-inclosing globe is secured in an air-tight or practically air-tight manner to the plate 27. In the lateral arm 36 of the depending arm 37 of the lamp is mounted a vertically-movable rod 38, the upper end 39 of  
 110 which is pointed or rounded and rests against a conical or rounded seat 40, formed on the under side of the plate. Spiral spring 41 encircles the rod, its lower end seating upon the arm 36, while its upper end engages a shoulder  
 115 42 on the rod. The spring-pressed rod serves to force the arc-inclosing globe upwardly and cause its upper end to fit snugly against its seat and form practically an air-tight joint therewith. The pointed bearing and conical  
 120 seat enable the upper end of the globe to adjust itself to its seat. By pulling down on the ring 43 and disengaging the pointed bearing from its conical seat the arc-inclosing globe may be removed to allow of the retrimming of the lamp.

125 The operation of the lamp is as follows: When no current is passing through the lamp, its carbons are in contact and the parts of its regulating mechanism are in the position  
 130 illustrated in Fig. 1. On the passage of current through the lamp it enters through conductor 44 and passes through the coarse-wire solenoid to the lamp-floor, from which it

passes through both carbons to the frame of the lamp, which is insulated at 45 from the lamp-floor, and through conductor 46 to line. Instantly the lamp is switched into circuit.

5 The coarse-wire solenoid is energized and pulls down its core and, through lifter 18, tilts the ring-clamp and causes it to grip and raise the upper carbon, and thus establish an arc between the carbons; but owing to the re-  
 10 tarding effect of the dash-pot the initial separating action of the two carbons will be very slow and gradual, and hence the result will be that an exceedingly minute arc will be first established, which will offer such a re-  
 15 sistance to the passage of the current that the adjacent ends of the carbons will be sufficiently heated to form a conducting-bridge of incandescent carbon vapor across the very narrow space or gap between them, and thus  
 20 preserve the integrity of the circuit through the lamp. The upper carbon continues to be so slowly and gradually lifted as will insure the maintenance of the arc, and this action continues until the arc has been drawn to its  
 25 desired length. When this point has been reached, the piston of the dash-pot will have reached the upper end of the smooth portion of the bore of the cylinder of the dash-pot, and the spring-contact 22 will engage contact  
 30 21, carried by the core of the shunt-magnet, with the result that a small portion of the current will be diverted through the shunt-magnet and cause it to lift its core and tilt lever 10, and thereby simultaneously move  
 35 the dash-pot cylinder downwardly and the adjustable floor or stop 16 upwardly, as shown in Fig. 2. It will now be observed that the adjustable floor or support 16 is lifted into close proximity to the under side of the ring-  
 40 clamp after the latter has been lifted to the height necessary to establish the desired length of arc, and hence a slight downward movement of the ring-clamp will now suffice to insure the adjustment and feed of the car-  
 45 bon. It will also be noted that the relative adjustment of the cylinder and piston of the dash-pot has been so changed that the piston is free to move upwardly and downwardly and throughout such a distance as will suffice  
 50 to insure the sensitive adjustment and feeding of the upper carbon, this freedom of action being insured by the grooves 12, formed in the upper portion of the cylinder, which allow the checking fluid to flow around the  
 55 piston as it is moved in either direction. In order to prevent the sudden lengthening of the arc, which might result in its extinguishment, an adjustable stop 54 is provided which limits the upward movement of the ring-clamp and carbon-holder, and hence restricts the  
 60 length of the arc. To insure the free action of the ring-clamp in its elevated position, an adjustable stop 55 is located beneath the lever 10 and serves as a stop to limit the upward move-  
 65 ment of the adjustable floor or support 16. As the arc continues to burn it gradually elongates and its resistance increases, with

the result that the pull of the coarse-wire solenoid is weakened and allows the carbon-holder and feeding carbon to descend until  
 70 the ring-clamp, by its engagement with support 16, relaxes its grip on the carbon-holder and allows the latter to gradually slide through it and feed the carbon. This action shortens the arc, decreases its resistance, and  
 75 correspondingly strengthens the coarse-wire solenoid, which instantly tilts the ring-clamp and causes it to grip and uphold the carbon-holder to which the feeding-carbon is se-  
 80 cured. In this manner the carbons are adjusted and fed until consumed, all of the adjustments necessary to the control and feed of the feeding-carbon being effected by the slight and sensitive action of the regulating mechanism, which, being at all times subject  
 85 to the slight retarding action of the dash-pot, insures a perfectly steady and reliable light. Owing to the fact that after the spring-contact 22 engages the contact 21 the latter is instantly raised and compresses the spring,  
 90 as shown in Fig. 2, these contacts are retained in engagement, during the operation of the regulating mechanism, until the carbons have been consumed. While the spring-contact is amply sufficient in size and con-  
 95 ductivity to maintain the integrity of the circuit through the shunt-solenoid, it is altogether too weak to interfere with the proper operation of the regulating mechanism, and the slight movement of one contact on the  
 100 other will keep their engaging surfaces always bright and clean and in good condition for reliable operation.

The opposite ends of the arc-inclosing globe are rendered practically air-tight, the lower  
 105 end by its fastening to the plate 27 and the upper end by its engagement with its seat on the under side of the lamp-floor and the packing encircling the carbon-holder. The spring-pressed rod upon which the globe is supported  
 110 is loosely mounted in the arm 36, so that it will permit the upper end of the globe to adjust itself to its seat.

To retrim the lamp, it is simply necessary to depress the spring-actuated rod 38, which  
 115 will allow the arc-inclosing globe and lower carbon to be removed, and thereby permit the carbon-holder to be cleaned and the carbons to be removed.

By applying the annular valve to the car-  
 120 bon-holder a much tighter and better joint can be secured than is possible when the valve is applied to the feeding carbon. The carbon-holder is a polished-metal rod, which is perfectly true and smooth, and hence will  
 125 work evenly and reliably within a comparatively tight-fitting packing-ring, while on the other hand a carbon-rod presents an irregular abrasive surface, which will not admit of the employment of a tight-fitting annular  
 130 valve around it and will soon wear the packing and allow of the ingress of more or less air to the globe.

The outer globe 56 is provided at its upper

end with a flat ground-seat 57, which seats against the under side of the lamp-floor and is retained in snug contact therewith by means of the two-part depending flange 58 on the casing. This flange is constructed with an inwardly-projecting rounded bearing 59, which bears against the outwardly-flaring flange 60 on the globe. The hinged portion 61 of the flange is opened for the reception of the globe, and when closed and fastened by the clamping-screw 62 the upper end of the globe will be forced into snug contact with its seat. Within the upper end of the globe is placed an expansible metal band 63, provided with a ring 64, which encircles the side support 37 and slides thereon. In trimming the lamp the clamp-screw 62 is loosened and the hinged section 61 of the flange is swung open, which permits the globe to be lowered and suspended by its ring from the lower end of the depending arm 37.

The arc-inclosing globe is shielded against the weather and additionally protected against the ingress of outer air thereto by means of the outer globe, into which is received any gases that may escape from the arc-inclosing globe. By retaining the latter against its seat by spring-pressure it will yield to any abnormal pressure therein and allow of the escape of gas into the outer globe.

Instead of making the arc-inclosing globe of one piece it may be made of two pieces, both of which may be of glass, or the upper section may be made of metal. Fig. 7 illustrates a two-part globe, the upper section of which is screwed into the lamp-floor around the recess in which is located the annular valve, while the lower section is provided with an outwardly-projecting flange 66, against which is seated the upper end of the lower section of the globe. This construction of globe enables its interior capacity to be reduced, because the inner diameter of the upper section 65 need only be just sufficient to admit the carbon holder and socket.

While I have only shown and described my invention as applied to one type of regulating mechanism, it is obvious that it can be applied to other types of regulators, as, for instance, to the shunt-magnet regulator, in which the adjustment and feed of the carbon are effected by the coaction of a shunt-magnet and spring, and also to a series regulator, in which the establishment of the arc and the adjustment and feed of the carbons are effected by the coaction of a coarse-wire magnet in the main circuit and a shunt-magnet in a circuit around the arc. Hence I do not restrict my invention in its application to the particular type of regulator shown and described. Again, I have shown and described an annular ring-valve as a suitable packing for the carbon-holder, but it is evident that other forms of packing may be employed for the same purpose, and hence I do not limit my invention to the particular form of packing shown and described.

The words "arc-inclosing globe," as employed in the claims, will comprehend a globe made in one piece or in sections.

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

1. In an arc-lamp, the combination with its carbons, and means for causing the carbons to be separated by a slow and gradual movement until an arc of normal length has been established, of means for automatically releasing the regulating mechanism from the action of such retarding mechanism and causing the feeding carbon to be sensitively adjusted and fed until consumed, substantially as set forth.

2. In an arc-lamp, the combination with the feeding carbon, means for retarding its initial separating movement, and means for checking its action while the lamp is burning an arc of normal length, of means for automatically releasing the feeding carbon from the action of its retarding mechanism and subjecting it to the action of its checking mechanism, substantially as set forth.

3. In an arc-lamp, the combination with its feeding carbon and means for slowly and gradually separating it from the non-feeding carbon and slowly drawing the arc to any desired length, of means for automatically relieving the regulating mechanism from the action of such retarding mechanism and means for adjusting the clutch-tripping mechanism, so as to insure the sensitive adjustment and feed of the carbon, and maintain an arc of predetermined length, substantially as set forth.

4. In an arc-lamp, the combination with its feeding carbon, means for slowly and gradually separating the feeding carbon from its mate and slowly drawing the arc to any desired length, and means for slightly checking the movement of the feeding carbon while the lamp is burning a normal arc, of means for automatically relieving the regulating mechanism from the action of such arc-drawing retarding mechanism, and means for automatically adjusting the clutch-tripping floor or device, to insure the maintenance of a normal arc, substantially as set forth.

5. In an arc-lamp, the combination with means for retarding the movement of the feeding carbon in establishing an arc of normal length, and an adjustable feed-releasing mechanism, of an electromagnet for automatically and simultaneously throwing the said retarding mechanism out of operation and the adjustable carbon-feeding mechanism into position when the arc has been drawn to its desired length, substantially as set forth.

6. In an arc-lamp the combination with its feeding carbon and regulating mechanism for establishing the arc and feeding the carbon, of a dash-pot constructed to retard the separation of the carbons in establishing the arc and render such separating movement slow and gradual, and means for automatically relieving the regulating mechanism of such arc-

drawing retarding mechanism, when the arc shall have been drawn to its normal length, substantially as set forth.

7. In an arc-lamp, the combination with the feeding carbon, and a dash-pot for retarding and controlling the movement of the carbon in drawing and in regulating the arc, of an electromagnet for automatically varying the degree of retardation of the dash-pot, substantially as set forth.

8. In an arc-lamp the combination with its feeding carbon and electromagnet-regulating mechanism, of a dash-pot the cylinder of which is provided with grooves throughout a portion of its length, and means for automatically adjusting the relative positions of the dash-pot cylinder and its piston, and thereby vary the retarding effect of the dash-pot on the action of the regulating mechanism, substantially as set forth.

9. In an arc-lamp the combination with its feeding carbon, and regulating mechanism for establishing the arc and feeding the carbon, of a dash-pot constructed to retard the movement of its position throughout a portion of its stroke, and to relieve the piston from a portion of such retarding action throughout the remaining portion of its stroke, and means for automatically varying the position of the cylinder of the dash-pot and its piston, substantially as set forth.

10. In an arc-lamp the combination with a friction-clutch and regulating mechanism adapted to raise the friction-clutch out of contact with the lamp-floor in the operation of establishing an arc of normal length, of an adjustable floor or support for the friction-clutch, an electromagnet; means for automatically switching said magnet into circuit when the arc has been drawn to its normal length and causing it to raise the adjustable floor or support, and means for restricting the upward movement of said floor or support and maintaining it in a position to actuate the friction-clutch and insure the gradual feeding of the carbon and the maintenance of an arc of normal length, substantially as set forth.

11. The combination with the regulating mechanism of an arc-lamp, an adjustable floor or support for a ring-clamp or friction-clutch, and an electromagnet for lifting said floor or support, of means whereby said electromagnet is retained out of circuit until an arc of normal length has been established and retained in circuit throughout the operation of the regulating mechanism in adjusting and feeding the carbon, substantially as set forth.

12. The combination with the regulating mechanism of an arc-lamp, an adjustable floor or support for a ring-clamp or friction-clutch and an electromagnet for lifting said floor or support, of a contact carried by the regulating mechanism, and a contact carried by the movable portion of the electromagnet, said contacts being constructed and arranged to remain separated until an arc of

normal length has been established, and then to be brought into and retained in contact and maintain the electromagnet in circuit throughout the burning of the carbons, substantially as set forth.

13. The combination with the regulating mechanism of an arc-lamp, and an adjustable floor or support for a ring-clamp or friction-clutch, of a shunt-magnet included in a high-resistance circuit around the arc, and means associated therewith for automatically switching the shunt-magnet into circuit and causing it to lift the adjustable floor or support after the arc has been drawn to the desired length, substantially as set forth.

14. The combination with the regulating mechanism of an arc-lamp, a lever, a dash-pot cylinder connected with one of its ends, and a friction-clutch floor or support with its other end, of an electromagnet for tilting said lever and simultaneously adjusting the dash-pot cylinder and the friction-clutch floor or support, substantially as set forth.

15. The combination with the regulating mechanism of an arc-lamp, an adjustable friction-clutch floor or support, and a shunt-magnet, of a contact mounted on a movable portion of the regulating mechanism, and a contact mounted on the movable portion of the electromagnet, one of said contacts being yielding, the parts being arranged to switch the electromagnet into circuit and cause it to lift the floor or support when an arc of predetermined length has been established, and to maintain the magnet in circuit throughout the burning of the carbons, substantially as set forth.

16. In an arc-lamp the combination with its carbons, carbon-holder or carbon-rod, and socket on the lower end of the rod, of an arc-inclosing globe, a seat against which the upper end of the globe snugly fits, an upwardly-spring-pressed support upon which the globe is mounted and a packing snugly encircling the carbon-rod and permanently retained thereon at a point above the socket in which the upper carbon is secured, substantially as set forth.

17. In an arc-lamp the combination with its feeding carbon, carbon rod or holder, arc-inclosing globe constructed and adapted to receive both carbons throughout their maximum length, the non-feeding carbon being secured to the cap upon the lower end of the globe, of an upwardly-spring-pressed support upon which the arc-inclosing globe is supported and by means of which its upper end is pressed against a stationary seat, and packing encircling the carbon rod or holder, substantially as set forth.

18. In an arc-lamp the combination with its carbons, carbon rod or holder and arc-inclosing globe the latter being constructed to receive both carbons throughout their maximum length, of a cover mounted on the upper end of the globe and provided with a hole through which the carbon-rod passes and

within which it snugly fits and an independent annular packing-ring seated on the lamp-floor and encircling the carbon-rod and serving to exclude the entrance of gases to the interior of the casing containing the regulating mechanism.

19. In an arc-lamp the combination with the lamp-floor and a globe provided with an outwardly-flaring flange at its upper end, the upper edge of the flange forming a seat, of a sectional depending flange on the lamp-casing, said flanges being provided with bear-

ings which engage the flange on the globe, and means for contracting the sectional flange and forcing the upper end of the globe against its seat on the under side of the lamp-floor, substantially as set forth.

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

HENRY A. SEYMOUR.

Witnesses:

S. W. FOSTER,

S. G. NOTTINGHAM.

S. I. CRAIN.  
ELECTRIC ARC LAMP.

No. 598,697.

Patented Feb. 8, 1898.

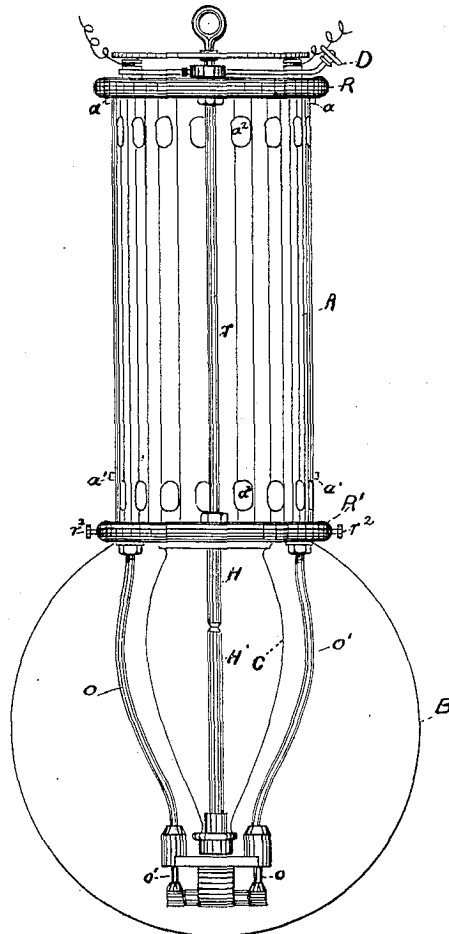


FIG. 1.

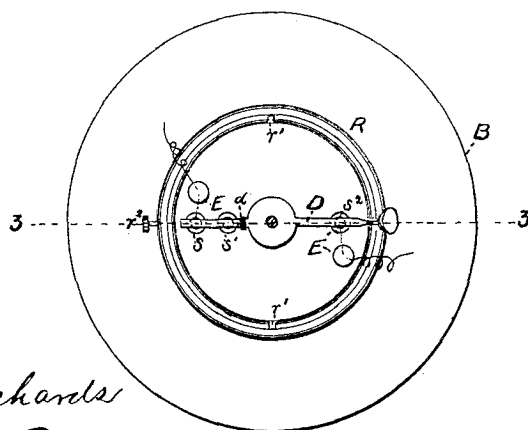


FIG. 2.

Witnesses  
*Brayton S. Richards*  
*Thomas D. Cory*

Inventor  
 SIDNEY I. CRAIN

By Attorney  
*George P. Jantzen*



# UNITED STATES PATENT OFFICE.

SIDNEY I. CRAIN, OF CINCINNATI, OHIO, ASSIGNOR OF TWO-THIRDS TO STEWART SHILLITO AND CHARLES A. IRWIN, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 598,697, dated February 8, 1898.

Application filed July 24, 1897. Serial No. 645,832. (No model.)

*To all whom it may concern:*

Be it known that I, SIDNEY I. CRAIN, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

The object of my invention is to produce an improved arc-lamp of the long-burning type in which the maximum efficiency and duration of the carbons is obtained in the minimum space and in which the parts can be easily assembled and are readily accessible for attention, repair, or replacement; and the invention consists in the parts and construction and arrangement of parts hereinafter described and claimed.

In the drawings, Figure 1 is an elevation of a lamp embodying my invention. Fig. 2 is a horizontal section on line 2 2 of Fig. 1. Fig. 3 is a vertical section on line 3 3 of Fig. 2. Fig. 4 is an elevation of a casing and tube which inclose the armature, the upper carbon, and the carbon-feeding mechanism; Fig. 5, a detail section of same; Fig. 6, a horizontal section on line 6 6 of Fig. 3; Fig. 7, a horizontal section on line 7 7 of Fig. 3. Fig. 8 is a horizontal section on line 8 8 of Fig. 5; Fig. 9, an elevation showing a combined lower-carbon holder and globe-support.

A represents a casing, preferably cylindrical in form, inclosing the working mechanism of the lamp; B, the outer globe; C, the inner globe; D, a switch for turning the current on or off, and E and E' the positive and negative electrical connection.

F, Fig. 3, is a solenoid-magnet; G, the resistance-coil; H, the upper carbon; H', the lower carbon, and I the armature.

Within the lower part of the casing A and below the magnet is a casing J, preferably cylindrical, inclosing the carbon-feeding mechanism. This casing is provided with relief-valves *j*, adapted to permit the gases to escape if the pressure becomes too great, but to prevent the admission of air. The casing is provided with a bottom plate *j'*, having a central opening through which the upper carbon passes. Extending upwardly from the top of this casing and having an air-tight connec-

tion therewith is a tube K, to the top of which may be fastened a ring *k*, by which the lamp may be supported. The armature I works in the tube K and carries a piston *i*, which works in casing J and serves to prevent sudden movement of the armature by reason of the limited passage for air from one side of the piston to the other. Depending from the piston *i* are arms *i'* and *i''*, to the lower ends of which are pivoted clutch-jaws L and L', adapted to engage with the upper carbon. These jaws are so arranged that the upward movement of the armature and its connections brings them into engagement with opposite sides of the carbon, which is thereby grasped and carried upward with the armature, while downward movement of the armature beyond a certain limit brings the jaws into engagement with the bottom plate *j'*, which serves as a fulcrum and releases their grip upon the carbon, leaving it free to fall. The mechanism above described constitutes the automatic regulator for the length of the arc.

Projecting upwardly from the bottom plate *j'* of casing J are studs *j''*, upon which are pivotally mounted arms *m*, which carry rollers M, adapted to engage with the upper carbon H. The upper carbon is provided with a cap N, having a reduced portion or neck *n* and a head *n'*, the outward flare *n''* between the neck and head being somewhat pronounced. In operation the upper carbon feeds downwardly until it is practically consumed, when the head of the cap engages with the rollers and the cap and the carbon it carries are held against further downward motion. This breaks the circuit, puts out the light, and serves notice upon the attendant that a new carbon is required. A slight pull on the carbon throws the rollers H far enough apart to permit the enlarged portion *n'* of the cap N to pass through and be removed from the lamp, after which the rollers fall together. In inserting the new carbon the cap N strikes the rollers and, forcing them apart, passes between them and into the tube K. The tube K, casing J, studs *j''*, arms *m*, and rollers M are all made of metal or other material which is a good electrical conductor, and the



tube K is connected with a switch D, so that an electrical path is provided between the switch and the upper carbon. By this arrangement the current connection with the upper carbon is made not far from its lower end, so that a long carbon may be used without the electrical resistance which would result if the current passed through the entire length of the carbon.

O and O' are supporting-rods secured to an annular flange  $j^3$ , extending outwardly from casing J, but insulated therefrom by insulators  $o$ . These rods have at their lower ends straight parts  $o'$ , upon which the support P for the inner globe and lower-carbon holder is adapted to slide. The lower ends of the rods are connected by means of a bar carrying an eccentric Q, adapted to engage with and raise or lower the globe and carbon-support P. The bottom plate  $j'$  of the casing J is provided with an annular groove  $j^4$ , adapted to receive and hold in position the upper end of the inner globe. This groove is preferably provided with a lining  $j^5$ , adapted to render the connection air-tight. It will be seen that by turning the eccentric the inner globe may be raised or lowered, thus giving easy access to its interior and permitting the globe or carbons, or both, to be readily removed.

R and R' are rings surrounding the upper and lower parts of casing A and connected by rods  $r$ . The casing A is provided with lugs  $a$  and  $a'$ , adapted to support ring R, and ring R is provided at suitable intervals with slots or grooves  $r'$ , adapted to permit the ring to slip over the lugs. The outer globe B is secured to the lower ring R' by means of set-screws  $r^2$ . It will be seen that the rings R and R', with their connecting-rods, constitute a rotatable frame which supports the outer globe. By rotating this frame until the grooves  $r'$  register with the lugs  $a$  the frame can be slipped downward from the casing, thereby giving free access to the interior without the necessity of detaching the outer globe. If desired, the frame may be supported upon lugs  $a'$  or it may be slipped over those lugs and entirely removed.

The solenoid F is preferably wound on a spool-frame  $f$ , adapted to slide down over tube K and rest upon casing J, and the resistance-coil G is wound on a spool-frame  $g$ , also adapted to slide over tube K and rest upon the magnet-frame. The protecting-casing A is provided with a series of apertures  $a^3$  for ventilation, and its top is closed by a plate S, preferably supported by the resistance-frame  $g$ .

The switch D and its connections are protected by a cap-plate T.

For making or breaking the electrical connections I prefer to employ the following mechanism: The top plate S is provided with three contact-points  $s$ ,  $s'$ , and  $s^2$ . The contact  $s$  is connected with the positive terminal,  $s^2$  with the negative, and  $s'$  with the resistance-coil. The switch-lever D is pivoted to

the top of the tube K and adapted to be swung into simultaneous engagement with all three of the contact-points. The switch-lever is electrically divided by means of insulating material at  $d$ , so that when it is in engagement with the three contact-points points  $s$  and  $s'$  are electrically connected with each other through the switch, and  $s^2$  is electrically connected with the tube K through the switch, but the current cannot pass through the switch from  $s$  and  $s'$  to  $s^2$  or the tube K, because of the insulation at  $d$ . When the current is turned on by means of the switch, the carbons being in contact, the current passes from the main wire through the contact-point  $s$ , switch D, contact  $s'$ , resistance-coil G, solenoid F, supporting-rod O, and carbon-support P to the lower carbon; thence through the upper carbon, rollers M, arms  $m$ , studs  $j^2$ , casing J, tube K, switch D, and contact-points  $s^2$  to the main wire.

My lamp operates on the same general plan as other arc-lamps—that is to say, when the current is turned on and the circuit established the armature is attracted upward, throwing the clutch-jaws into engagement with the upper carbon and raising it sufficiently to afford the required arc. As the carbons burn away and the resistance increases the armature and the parts connected therewith drop, the upper carbon is released and drops until the resistance is decreased sufficiently to cause the armature to be again attracted upwardly, and to thereby again bring the clutch-jaws into engagement with the carbon.

The bottom plate  $j'$  of casing J is provided with apertures  $j^5$ , which permit the passage of air between the space inclosed by the casing and that inclosed by the inner globe. It will be seen that the space inclosed by the inner globe C, the casing J, and the tube K is practically air-tight. When the current is turned on and the light started, the oxygen in the air inclosed in this space is converted into other gases, and as no more air can enter the arc is produced in a non-combustion supporting medium and the duration of the carbons is greatly increased.

The bottom plate  $j'$  is detachably secured to the casing by means of thumb-screws  $j^6$ . By removing this plate all of the mechanism within the casing and tube may be removed.

I claim—

1. The combination, in an arc-lamp, of the magnet, F; the casing, J; the tube, K; the armature, I, adapted to work in the tube, K; the piston,  $i$ , carried by the armature and adapted to work in the casing, J; the arms,  $i'$ , depending from the piston and rigidly attached thereto; and the clutch-jaws, L, pivoted to the arms, substantially as and for the purpose set forth.

2. The combination, in an arc-lamp, of a pair of pivoted arms carrying rollers adapted to engage with the upper carbon at or near its point of support and electrical connection

between the rollers and the main, substantially as and for the purpose set forth.

3. The combination, in an arc-lamp, of a cap for the upper carbon having a head or knob; a pair of pivoted arms carrying rollers adapted to contact with opposite sides of the carbon during its downward travel and to engage with the head or knob of the cap and arrest its downward travel, substantially as and for the purpose set forth.

4. The combination, in an arc-lamp, of the casing, J; the tube, K; the bottom plate,  $j'$ , having groove,  $j^4$ , adapted to receive the top of the inner globe, C; a packing,  $j^5$ , in the groove adapted to make an air-tight connection between the casing and the globe; ports,  $j^6$ , adapted to permit passage of air between the casing and the globe; the supporting-rods, O and O'; the globe-support, P; and the eccentric, Q, adapted to raise or lower the globe, substantially as and for the purpose set forth.

5. The combination, in an arc-lamp, of the casing, A, having lugs,  $a$ ; the ring, R, having grooves adapted to pass over the lugs, the rings, R', adapted to support the outer globe;

and the connecting-rods,  $r$ , substantially as and for the purpose set forth.

6. The combination, in an arc-lamp, of the casing, A, having lugs,  $a$ ; the ring, R, having grooves adapted to pass over the lugs; the ring, R', adapted to support the outer globe; the connecting-rods,  $r$ ; the supporting-rods, O and O'; the globe-support, P; and the eccentric, Q, adapted to raise or lower the globe, substantially as and for the purpose set forth.

7. The combination, in an arc-lamp, of an outer casing, an inner casing inclosing the carbon-operating mechanism, and having a removable bottom plate, a tube extending upwardly from the inner casing, and a magnet-frame and a resistance-frame, both having bores adapted to take over the upwardly-extending tube and held in position by gravity, substantially as and for the purpose set forth.

SIDNEY I. CRAIN.

Witnesses:

BRAYTON G. RICHARDS,  
THOMAS D. CORRY.

A. HAMACEK.  
ELECTRIC ARC LAMP.

(Application filed May 12, 1899.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.

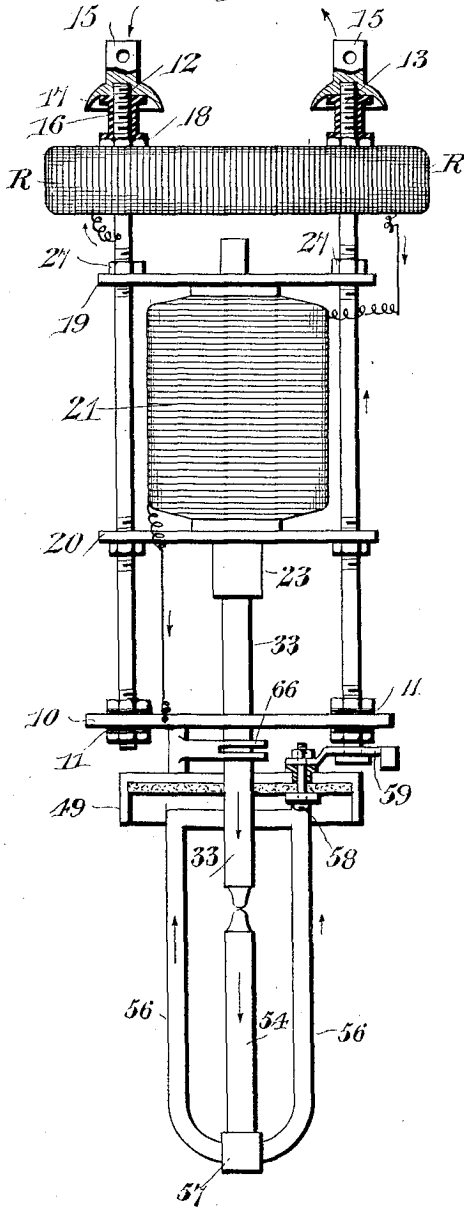
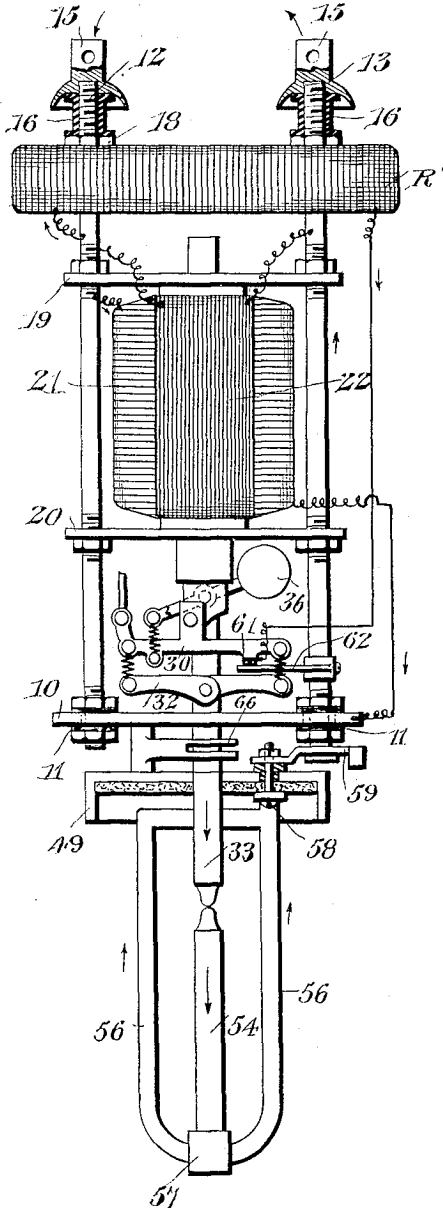


Fig. 2.



Witnesses

*Jas. L. McClellan*  
*O. B. Roy*

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By *T. H. S.* Attorneys

*C. A. Snow & Co.*

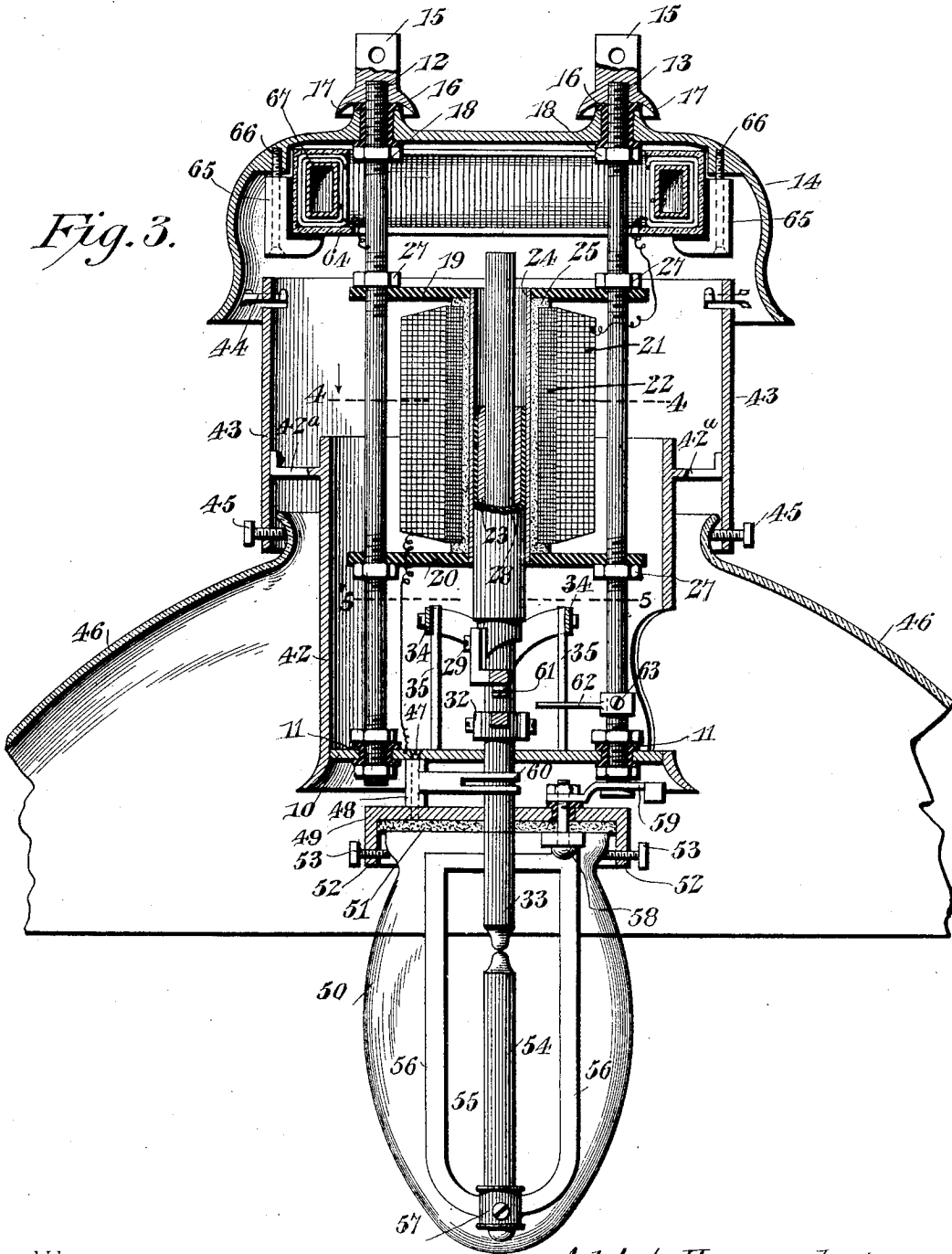
A. HAMACEK.  
ELECTRIC ARC LAMP.

(Application filed May 12, 1899.)

(No Model.)

3 Sheets—Sheet 2.

Fig. 3.



Witnesses

*Jas. K. McLathrum*  
*[Signature]*

*Adolph Hamacek* Inventor

By *Tris* Attorneys.

*C. Snow & Co.*

A. HAMACEK.  
ELECTRIC ARC LAMP.

(Application filed May 12, 1899.)

(No Model.)

3 Sheets—Sheet 3.

Fig. 4.

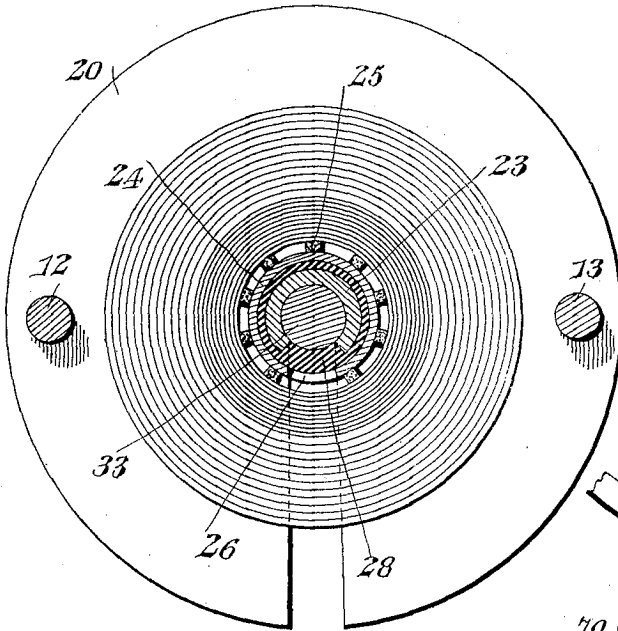


Fig. 5.

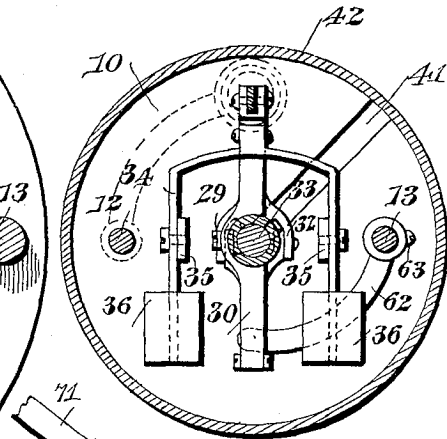


Fig. 7.

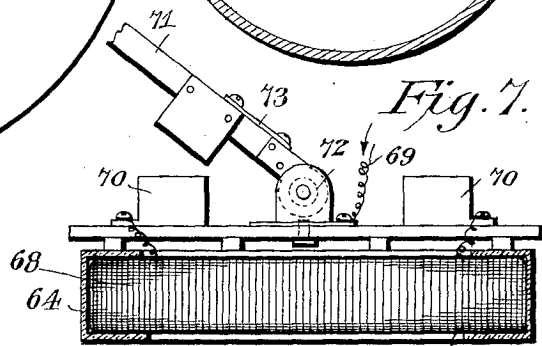


Fig. 6.

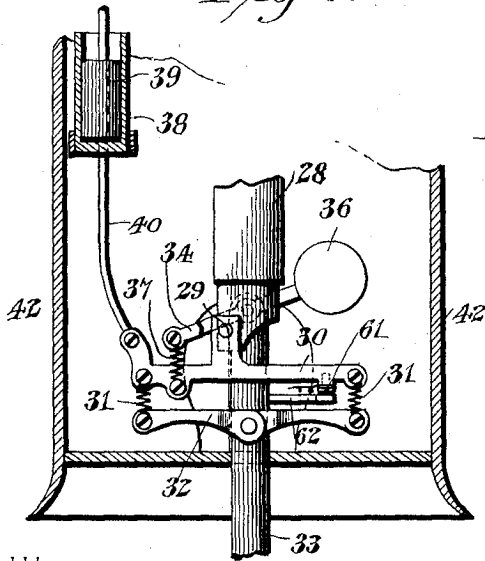
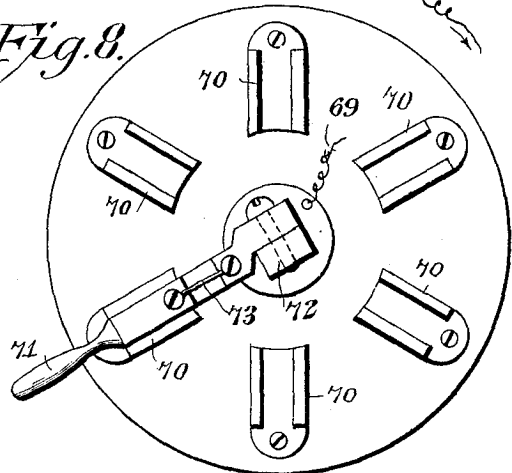


Fig. 8.



Witnesses

*Jas. S. McLaughlin*  
*[Signature]*

*Adolph Hamacek* Inventor  
By *His* Attorneys,

*C. A. Snow & Co.*

# UNITED STATES PATENT OFFICE.

ADOLPH HAMACEK, OF STURGEON BAY, WISCONSIN.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 634,085, dated October 3, 1899.

Application filed May 12, 1899. Serial No. 716,560. (No model.)

*To all whom it may concern:*

Be it known that I, ADOLPH HAMACEK, a citizen of the United States, residing at Sturgeon Bay, in the county of Door and State of Wisconsin, have invented a new and useful Arc-Lamp, of which the following is a specification.

My invention relates to electric lighting, and particularly to arc-lamps; and the primary object in view is to provide a lamp of such construction as to adapt it, with slight variations in wiring, for use in connection with constant-potential direct and alternating currents and with series direct and series alternating currents.

A further object of my invention is to provide means whereby the feeding of the positive carbon may be accomplished noiselessly in connection with a high-frequency alternating current and whereby the feeding of the carbon is accomplished positively, the parts being returned to an initial position should the circuit be broken to reestablish the original conditions and strike the arc.

A further object of my invention is to provide a simple, compact, and efficient construction and arrangement of parts whereby the solenoid may be adjusted with relation to the armature or plunger or may be readily detached from its supporting devices within the lamp-casing.

A further object of the invention is to provide means for preventing inductive currents even in those portions of the structure which are necessarily metallic, and particularly to provide the solenoid with a shunt or secondary winding concentric with the primary winding and fit the solenoid with a bushing of such construction as to prevent inductive currents, whereby the strength of current necessary for operating the lamp may be reduced to the minimum, and also whereby the inductive heating of the operating parts may be prevented to insure an efficient cooperation thereof.

A further object of the invention is to provide a negative-carbon support or lead of such construction as to induce a centralization of the arc between the carbon-terminals by centralizing the concentration of gases within the globe and at the same time provide a support which will interfere to the minimum extent with the distribution of the rays of light.

A further object of the invention is to provide simple and efficient means for supporting and connecting the elements of a non-magnetic and non-conductive casing and related parts.

A further object of the invention is to reduce to the minimum the communication of heat from the globe to the operative parts of the structure, whereby the relative expansion and contraction of the parts may be reduced.

Further objects and advantages of this invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims, it being understood that the improvement is susceptible of various changes in the form, proportion, and minor details of construction without departing from the spirit or sacrificing any of the advantages thereof.

To a full disclosure of the invention an embodiment thereof is shown in the accompanying drawings, wherein—

Figures 1 and 2 are diagrammatic views showing the circuit connections of the lamp embodying my invention when used, respectively, in connection with constant-potential multiple-arc direct and alternating circuits and series direct and alternating circuits. Fig. 3 is a vertical central sectional view of an arc-lamp constructed in accordance with my invention. Fig. 4 is a transverse horizontal section on the plane indicated by the line 4 4 of Fig. 3. Fig. 5 is a transverse horizontal section on the plane indicated by the line 5 5 of Fig. 3. Fig. 6 is a detail vertical sectional view of the clutch mechanism and related parts upon a plane at right angles to that of Fig. 3. Fig. 7 is a detail sectional view of the resistance device, showing the switch-arm, contacts, and connections. Fig. 8 is a plan view of the resistance device.

Similar reference characters indicate corresponding parts in all the figures of the drawings.

Connected with the base 10 of the lamp, with suitable interposed insulation 11, are the positive and negative lamp poles or leads 12 and 13, consisting of rods which in turn support the hood 14 and which are provided above the hood with suspending-terminals 15, the hood being insulated from the poles, as shown at 16, and the suspending devices 15

being provided with pendent guard-flanges 17 to exclude moisture from the interior of the lamp structure. In the construction illustrated the suspending devices 15 are threaded upon the upper extremities of the rods 12 and 13, and nuts 18 are correspondingly threaded upon the rods below the plane of the hood to maintain the latter in the desired position.

Supported by the poles 12 and 13 and between the same, by means of insulating upper and lower plates 19 and 20, is a solenoid having the exterior primary or coarse winding 21 and the concentric interior secondary or fine winding 22, the fine winding being in the opposite direction to the coarse winding to constitute an opposing or shunt resistance to affect the armature or plunger 23 when the lamp is arranged in a series circuit, said armature or plunger constituting the positive-carbon carrier or holder. The solenoid is provided with a bushing 24, separated from the winding by heat-insulating strips 25 of asbestos to form intermediate air-spaces, said bushing being split or cut away at one side throughout its length from its inner to its outer surface to form an opening 26 to prevent inductive heating by breaking the inductive circuit. In the construction illustrated the solenoid-bushing 24 is terminally secured in openings in the insulating-plates 19 and 20, while the heat-insulating strips 25 are terminally offset to bear against the opposing surfaces of said plates, and the plates are secured at the desired adjustment upon the lamp-poles 12 and 13 to support the solenoid in the desired position with relation to the armature or plunger by means of adjusting devices, such as nuts 27. The armature or plunger is also split or cut away from its core to its outer surface to prevent inductive heating and is inclosed in an insulating-sheath 28.

Rigidly attached to the armature or plunger, as by a screw 29 or other fastening device, is a cross-head 30, and from the extremities of the arms of the cross-head depend fine-wire connections 31, which support the outer extremities of the members 32 of a carbon clutch or grip, the adjacent extremities of said members 32 being pivotally connected and said inner extremities constituting jaws, between which extends the positive or upper carbon 33. When the clutch is supported by the connections 31 at the outer extremities of the members 32, the jaws of the clutch are held in frictional engagement with the carbon to prevent the latter from slipping downward, and arranged in the path of downward movement of the connected extremities of the members 32 is the base 10, whereby when the cross-head 30 is lowered by the weakening of the solenoid the connected portions of the members of the clutch come in contact with said stop, and thus allow the jaws to open to permit the downward feeding of the carbon independently of the clutch or through the clutch. To neutralize the effect of the weight

of the cross-head 30 and the clutch, I employ a counterbalancing device, consisting of a forked lever 34, of which the arms are pivoted upon standards 35, rising from the base 10, and are provided with terminal weights 36, and between the inner end of said lever and the cross-head is arranged a flexible connection 37, similar to the connections 31, by which motion is communicated from the cross-head to the members of the clutch. Thus it will be seen that the effect of the counterbalancing device is to relieve the solenoid of the weight of the cross-head and clutch with their connections, whereby the strength of the solenoid need be sufficient only to raise the armature or plunger.

The above-described relation between the members of the carbon-supporting devices, including the connections between the cross-head and the clutch members, is such as to allow the feeding of the carbon with comparative uniformity and little noise; but in order to still further guard against jar and shock, particularly when the device is used in connection with alternating currents, I preferably employ a dash-pot 38 for cushioning the upward and downward movements of the cross-head, the piston 39, which operates in the dash-pot, being flexibly connected by a rod 40 with the cross-head. It will be understood that the dash-pot serves to cushion both the upward and downward movements of the carbon-carrying mechanism.

Surrounding the base 10, which is cut away from its center to its periphery, as shown at 41, to prevent inductive heating, is a casing-sleeve 42, which is perforated or provided with openings to allow circulation of air within the same, and inclosing the upper portion of this sleeve, which is open at its upper end and attached thereto by brackets 42<sup>a</sup>, is a sheath 43, of larger diameter than the sleeve 42 and also open at its upper and lower ends. This sheath, however, is supported by the hood 14, with its upper edge arranged within the space inclosed by the lower edge of the hood, said hood being provided with inwardly-extending supporting pins or brackets 44, having a bayonet-slot connection with the sheath. At its lower edge the sheath is provided with set-screws 45 or other attaching devices for a shade 46, the upper edge of the shade being fitted within the space inclosed by the lower edge of the sheath, and hence being overlapped by the latter to prevent access of rain or snow to the interior of the structure. The sleeve and sheath when disconnected from the hood are adapted to be displaced downwardly, and preferably said parts are constructed of non-magnetic and non-conductive material—such as porcelain, glass, or the equivalent thereof. Also the lower casing member 42 is provided below the plane of the base 10 with a flared lower edge.

Arranged below the base and supported out of contact therewith by means of screw-rods 47 and incasing sleeves 48 is a cap-plate 49,

which in turn supports the lamp-globe 50, a heat-insulating disk 51, of asbestos or equivalent material, being interposed between the upper edge of the globe and said cap to prevent the conduction of heat and at the same time to form a cushion to receive the upper edge of the globe, whereby differential expansions of the parts may not serve to affect the integrity of the globe. Said insulating-cushion may be protected by a depending flange 52 on the cap, and this flange may carry globe-attaching set-screws 53. The positive carbon depends from the interior of the casing through the cap-plate and into the globe 50 for terminal contact with the lower or negative carbon 54, which is supported within the globe by means of a hanger 55. In the construction illustrated this hanger consists of a plurality of cross-sectionally flat leads 56, arranged at uniform intervals around the carbons and at a uniform distance therefrom and with their edge portions facing the carbons, and said leads, which are spread or arched outwardly in planes radiating from the carbons, are united at their lower extremities to form a socket 57, designed for the reception of the lower or negative carbon. The peculiar construction of this support is designed to insure a fixed non-vibratory support for the lower carbon, while affording the least possible obstruction to the rays of light emanating from the arc, and it is obvious that the disposition of the leads, with their widths or side surfaces in radial planes and arched, as described, will serve to effectually brace the socket 57 against lateral vibration. Furthermore, however, the uniform spacing or distribution of the leads around the carbons serves to prevent a non-uniform deflection of the gases within the globe and cause a uniform circulation thereof, which tends to centralize the arc between the extremities of the carbons, and thus insure a more uniform consumption of the carbons. The leads of the negative-carbon support are connected with the negative pole 13 by means of a connecting-pin 58 and a switch 59, and the connection between the positive element of the lamp structure and the positive carbon is effected by means of a brush 60, carried by the base 10, said base constituting one of the elements of the circuit between the solenoid and the positive carbon.

The cross-head 30 carries a series contact 61, and attached to the negative pole 13 is a cooperating series contact 62, consisting of an arm held at the desired adjustment with relation to the rod 13 by means of a set-screw 63. Also this stationary contact 62 is adapted to be turned upon the rod 13 out of the path of the movable contact 61, said movable contact being actuated by the solenoid through a cross-head, which is carried of the armature or plunger.

In addition to the above-described mechanism I also employ a resistance device, which may be arranged either within the lamp-cas-

ing or exteriorly thereof, as may be preferred. As shown in the drawings, Fig. 3, this resistance device is arranged within and is supported by the hood 14, and consists of a suitable non-magnetic and non-conductive casing 64, of porcelain or its equivalent, engaged by clips 65, which are adjustably attached to the hood by means of screws 66. Obviously the specific construction of this resistance device may be varied to suit the peculiarities of the circuit and current with which the lamp may be used. For instance, in connection with a multiple-arc constant-potential alternating current I employ a resistance device consisting of a reactive conduction-coil, comprising a magnetic soft-iron core 67, of sheet metal, provided with insulated or skeleton winding 68, having a leading-in connection 69 and a plurality of terminal contacts 70, said leading-in connection being attached to a switch 71, which is pivotally mounted upon a swivel-pin 72 and is adapted to be arranged in operative relation with either of the contacts 70 to cut in any desired proportion of the resistance device, according to the requirements of the current. The switch may also be provided with a fuse 73. The switch whereby the resistance may be varied or adjusted is not illustrated in connection with the diagrammatic representation of the resistance device shown in Fig. 3, as it is obvious that the controlling-switch may be arranged in any desired position with relation to the coil, or, if preferred, the entire resistance device, including the switch and coil, may be arranged exteriorly of the lamp-casing, without departing from the spirit of my invention.

In Fig. 1 I have shown the connections and wiring whereby the lamp embodying my invention is adapted for use in connection with a constant-potential alternating current in a multiple-arc circuit, from which it will be seen that from the positive pole 12 the current passes through the reactive induction resistance-coil to the coarse or primary winding of the solenoid and thence to the base 10, through the brush to the carbons, and finally through the leads 56 and the switch 59 to the negative pole 13 and out. It will be understood that the function of the reactive resistance device consists in setting up counter induced currents which oppose the original or primary current, and thus interfere and impede or counteract the effect of the primary current to an extent proportionate to the length of the winding which is arranged in the circuit and to the strength of the current. With the parts in their original positions the carbons are terminally in contact, the armature or plunger, with the cross-head and clutch supported thereby, being depressed; but upon passing a current through the lamp the solenoid is energized and the armature is elevated to cause the clutch members 32 to grip the positive carbon, and thus raise the same to strike the arc. As the re-



sistance of the arc due to the abnormal separation of the carbon terminals increases the effect of the solenoid upon the armature is lessened, and consequently the armature is allowed to descend gradually to maintain an approximately uniform interval between the carbon-points. When this depression of the armature has proceeded sufficiently to bring the connected extremities of the clutch members into contact with the stop formed by the upper surface of the base, the jaws of the clutch will be opened and the carbon will be fed downward to reduce the arc resistance, whereupon the solenoid will increase in strength to again raise the armature. Should the current cease for any cause, the armature will drop to its original position and the clutch will be opened to release the positive carbon and allow it to drop until checked by contact with the extremity of the negative carbon. The suddenness, however, of the change in the relative positions of the parts will be cushioned by the dash-pot and will also be relieved by the flexible connections between the cross-rod and the clutch members.

To adapt the lamp for use in connection with a direct current in a multiple-arc circuit, it is necessary simply to substitute an ordinary resistance-coil for the reactive resistance device, said resistance-coil consisting of a non-magnetic core having a German-silver winding, the connections being identical with those hereinbefore described and shown in Fig. 1.

For use in connection with either direct or alternating currents in series circuits I employ a resistance-coil  $R'$ , Fig. 2, which may be located in the same relative position in the lamp-casing as the resistance device  $R$ , Fig. 1, said resistance-coil being connected at one end with the positive pole of the lamp and having its other end connected with the movable series contact 61, the coarse or primary winding of the solenoid being connected at one end with the positive pole 12 and at the other end with the plate 10; but in series lighting I employ the hereinbefore-described secondary or fine winding of the solenoid, the ends of said winding being connected, respectively, with the positive and negative poles 12 and 13 of the lamp to bridge the same, and thus constitute a shunt-resistance. With this relation between the parts the current passes from the positive pole, first, through the resistance-coil  $R'$  to the movable contact 61, and thence through the stationary contact 62 (which in series lighting is arranged in the path of said contact 61) to the negative pole; second, through the solenoid-winding 21 to the plate 10, and thence through the carbons and the switch 59 to the negative pole, and, third, from the positive pole through the secondary solenoid-winding to the negative pole, a very small proportion, however, passing through said secondary winding. As soon as the current is turned into the lamp, therefore,

there is the passage of a small portion thereof through the primary solenoid-winding; but this is sufficient to energize the solenoid to the extent necessary to raise the cross-head and open the circuit through the resistance at 61 and turn all current through carbon and strike the arc. The raising of the cross-head separates the contacts 61 and 62, and thereby cuts out the resistance before the positive carbon is raised from the negative, and hence closes the entire current through the solenoid. An important feature of my improved construction resides in the fact that in series lighting the striking of the arc is accompanied by the cutting out of all resistance, and thus allowing the entire current to pass through the solenoid and the carbons. As the separation between the points of the carbons increases and the elevating effect of the primary solenoid decreases the opposite effect of the secondary solenoid-winding increases to induce a greater opposition to the elevating effect to the main solenoid-winding, and thus lower the armature or plunger to cause the reduction of the interval between the carbon-points. When the downward tendency of the secondary winding becomes efficient to overcome the opposite tendency of the primary winding and brings the connected extremities of the clutch members into contact with the fixed stop formed by the base-plate 10, the carbon will be released and allowed to drop and assume a position necessary to form a normal arc, as hereinbefore described in connection with the arrangement of parts illustrated in Fig. 1.

It will be seen from the foregoing description that in addition to cushioning the parts and so relating them as to produce a noiseless carbon-feeding mechanism and also in addition to providing means for preventing inductive heating of the metallic parts of the structure (all of those parts which are not necessarily metallic being of non-magnetic and non-conductive material) I have arranged the operating parts of the mechanism entirely outside of the globe and removed from the point at which the arc is formed and at the same time have inclosed the carbon-terminals to exclude currents of air and other influences liable to affect the centralization of the arc.

Furthermore, from the foregoing description it will be seen that I have separated the globe-cap from the base of the lamp-casing to form an intervening air-space in which the switch 59 for controlling the passage of the current through the lamp is located, and, furthermore, have insulated the cap from the globe by an interposed cushion.

Furthermore, it will be seen that the necessary adjustment of the connections to adapt the lamp embodying my invention to either of the kinds of currents in use may be accomplished with facility and that the lamp is simple in construction and that the parts

may be readily disconnected to give access to the interior for cleaning and repairing.

Having described my invention, what I claim is—

5 1. In an arc-lamp, a solenoid, a resistance device, an armature or plunger actuated by the solenoid, a carbon-carrier and a connected clutch, a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier, and a dash-pot having its piston connected with the carrier, substantially as specified.

15 2. In an arc-lamp, a solenoid, a resistance device, an armature or plunger actuated by the solenoid, a carbon-carrier supported by the armature or plunger, a carbon-clutch flexibly connected with the carrier and having pivotally-connected jaws, cushioning devices for resisting the movements in opposite directions of the carrier, a stop arranged in the path of the pivotally-connected ends of the clutch-jaws and a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier, substantially as specified.

25 3. In an arc-lamp, the combination of a base and a hood, rods connecting the base and hood and forming circuit-poles, a sheath detachably connected with the hood and loosely fitted at its upper edge within the same, means carried by the sheath for supporting a shade, and a sleeve connected with and supported by the same, and arranged at its lower end to inclose the base, substantially as specified.

35 4. In an arc-lamp, the combination of a base and a hood, rods connecting the base and hood and forming circuit-poles, a sheath having a bayonet-joint connection with the hood and spaced therefrom to form a ventilating-opening, means carried by the sheath for supporting a shade, and a sleeve carried by the sheath, arranged at its lower end to surround said base, and provided with an air-inlet opening, substantially as specified.

45 5. In an arc-lamp, the combination with a casing having a base and a connected hood, a solenoid arranged within the casing, a carbon-carrier actuated by the solenoid, a carbon-clutch flexibly connected with the carrier and a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier and clutch, and a globe-supporting cap arranged below the base and supported thereby to

form an intervening air-space, substantially as specified.

6. In an arc-lamp, the combination with a casing having a base and a connected hood, a solenoid arranged within the casing, a carbon-carrier actuated by the solenoid, a carbon-clutch flexibly connected with the carrier and a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier and clutch, a cap supported below and at an interval from said base to form an air-space, an arc-inclosing globe supported by said cap, and a cushion interposed between the globe and said cap, substantially as specified.

7. In an arc-lamp, the combination with a casing having a base and a connected hood, a solenoid arranged within the casing, a carbon-carrier actuated by the solenoid, a carbon-clutch flexibly connected with the carrier and a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier and clutch, a cap supported below and at an interval from said base to form an air-space, an arc-inclosing globe supported by said cap, and a heat-non-conducting cushion interposed between the upper edge of the globe and the adjacent surface of said cap, substantially as specified.

8. In an arc-lamp, a solenoid having a longitudinally-slotted bushing, a longitudinally-slotted armature fitted for reciprocatory movement in the bushing, and provided with an exterior insulation, a resistance device, the armature or plunger being adapted for actuation by the solenoid, a carbon-carrier supported by the armature, a carbon-clutch flexibly connected with the carrier and having pivotally-connected jaws, cushioning devices for resisting the movements in opposite directions of the carrier, a stop arranged in the path of the pivotally-connected ends of the clutch-jaws, and a counterbalancing-lever flexibly connected with the carrier and adapted to counterbalance the weight of the carrier.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

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Witnesses:

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No. 637,060.

Patented Nov. 14, 1899.

T. E. ADAMS.  
ELECTRIC ARC LAMP.

(Application filed Nov. 8, 1898.)

(No Model.)

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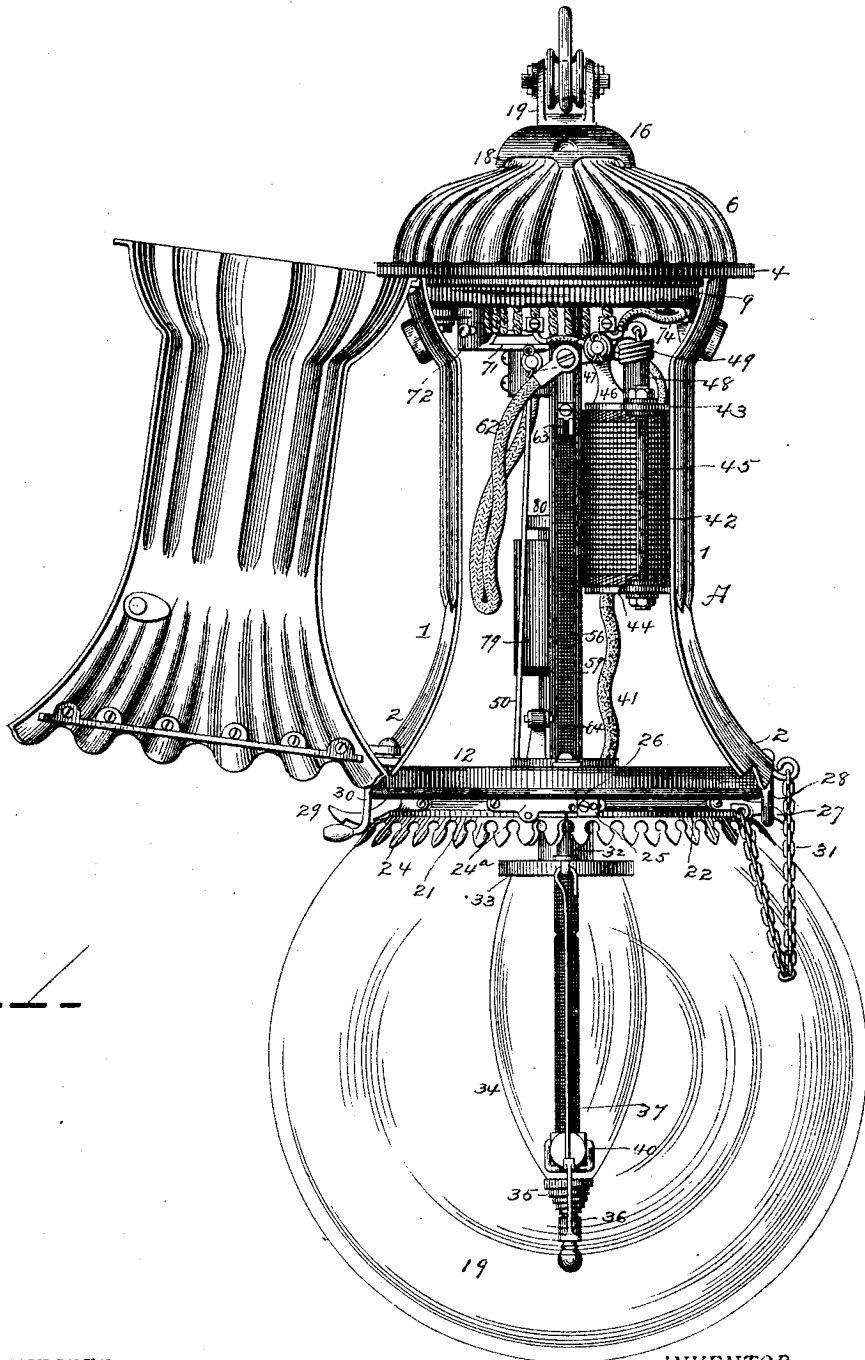


FIG. 1

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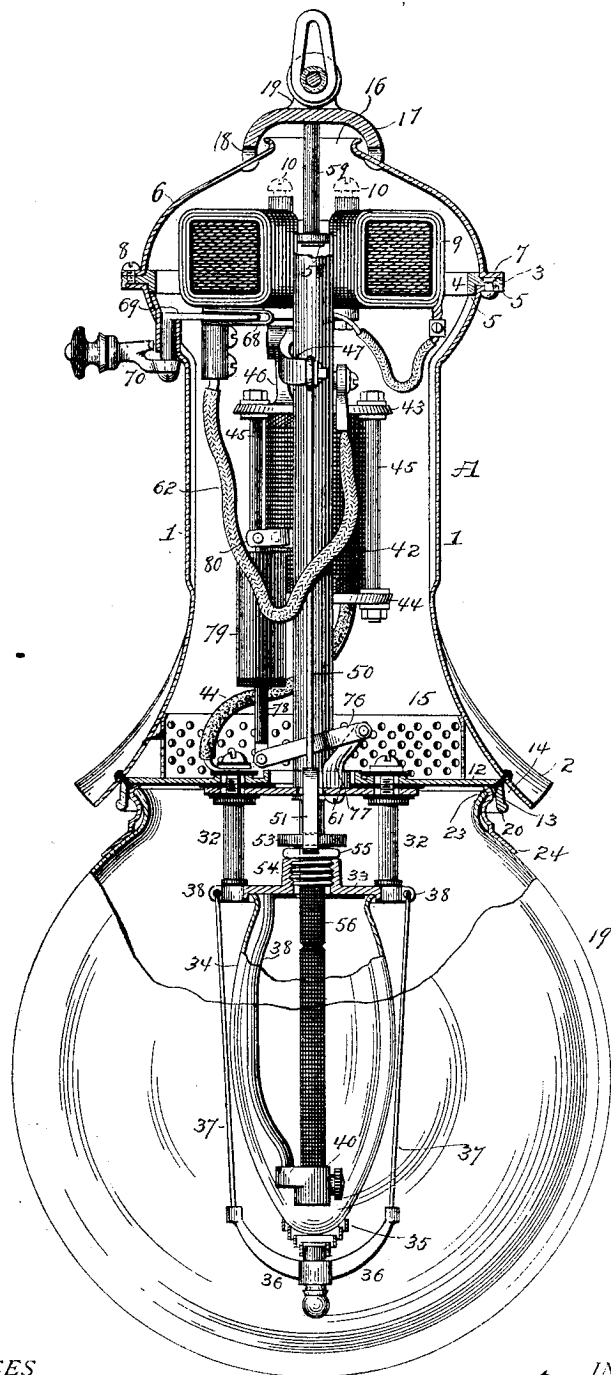
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FIG. 2.



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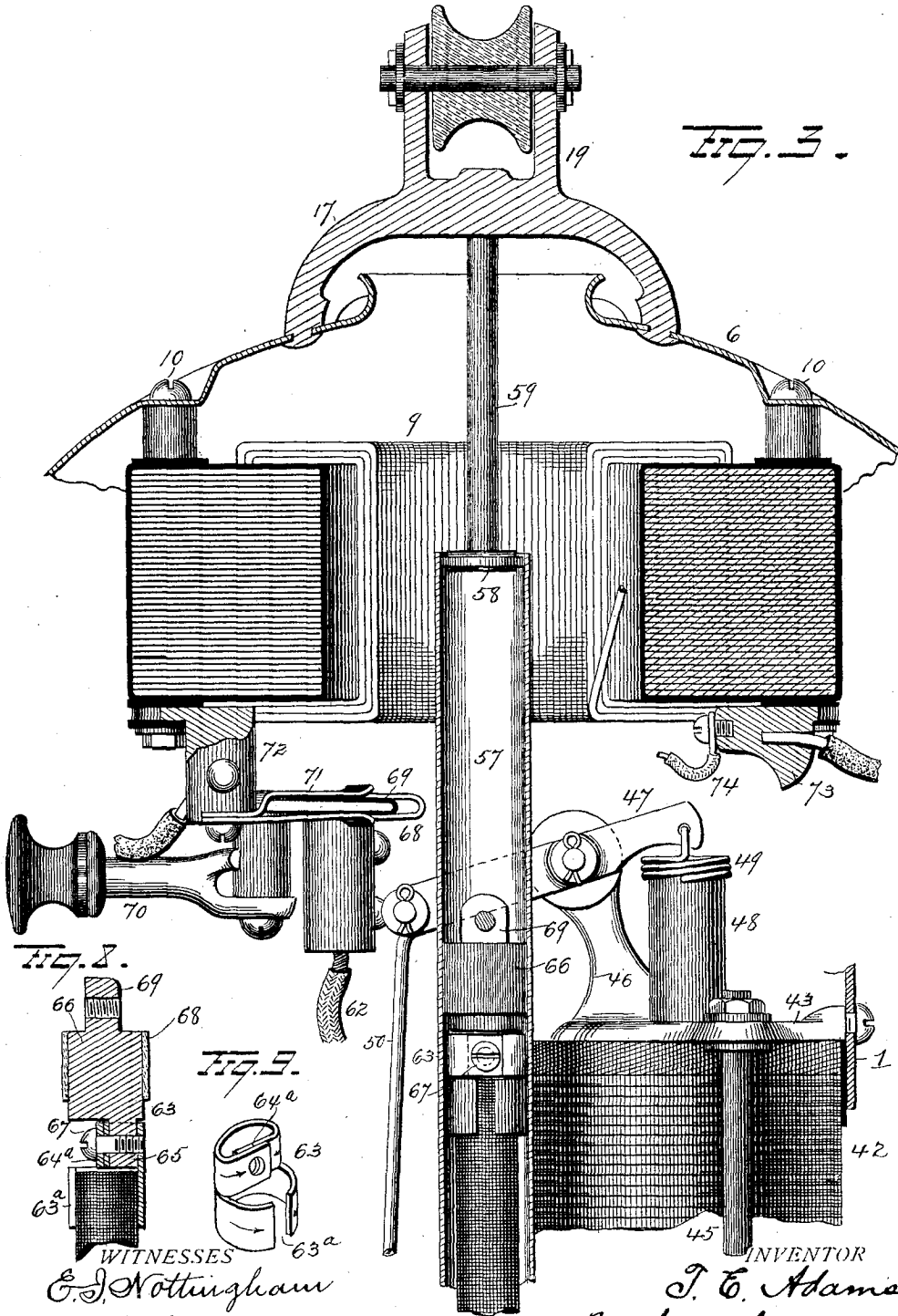
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5 Sheets—Sheet 3.



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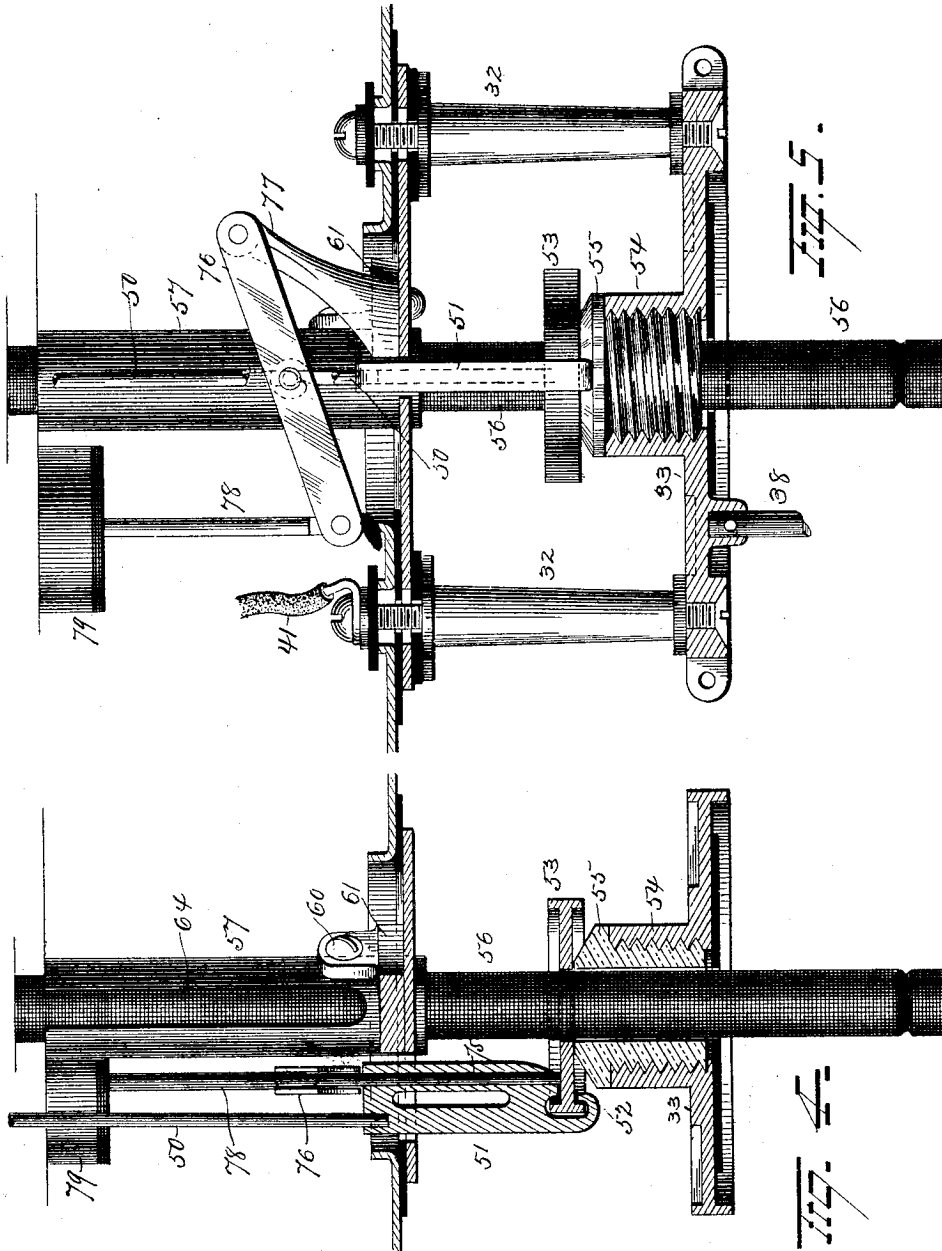
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5 Sheets—Sheet 4.



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(No Model.)

5 Sheets—Sheet 5.

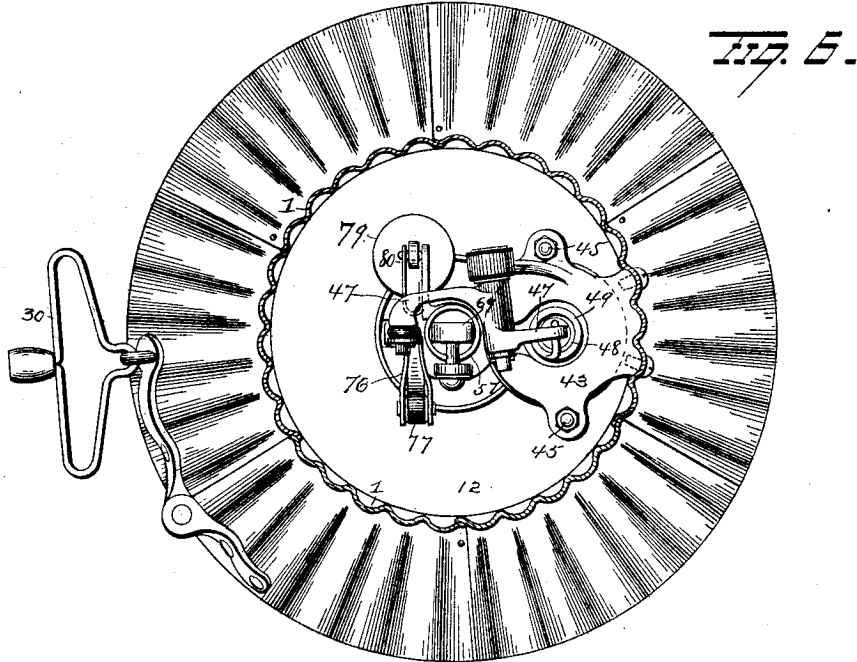


Fig. 5.

Fig. 7.

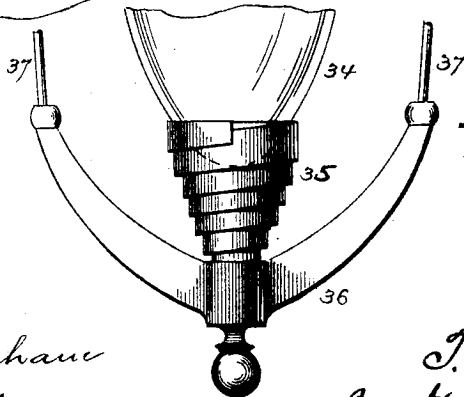
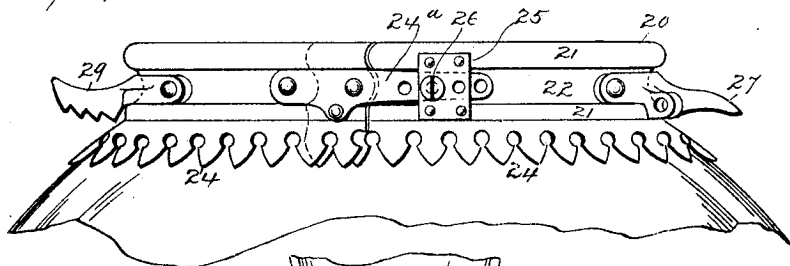


Fig. 8.

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# UNITED STATES PATENT OFFICE.

THOMAS EDGAR ADAMS, OF CLEVELAND, OHIO.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 637,060, dated November 14, 1899.

Application filed November 8, 1898. Serial No. 695,840. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS EDGAR ADAMS, 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 adapted to operate with alternating electric currents, one object of the invention being to produce an arc-inclosed electric-arc lamp adapted to burn on multiple-arc circuits which shall be of simple construction and comprise a minimum number of movable parts.

A further object is to provide efficient means whereby to overcome the liability of the carbon "shaking through" the clutch on account of the violent vibrations incident to an arc-lamp when used with an alternating current.

A further object is to so construct a lamp-casing of sheet metal as to render it capable of supporting the regulating mechanism without danger of derangement of said mechanism on account of strain to which the casing may be subjected.

A further object is to provide a casing for an arc-lamp which shall be strong and durable and at the same time light in weight.

A further object is to so construct a casing for an arc-lamp that all the mechanism shall be readily accessible and removable for repair, cleaning, or inspection.

A further object is to provide means whereby to convey current direct to an upper carbon moving in a tube without the use of sliding contacts.

A further object is to so arrange an annular or ring clutch that it shall be free to turn and assume new positions upon the surface of the carbon to distribute the wear over the entire inner face of the clutch and at the same time prevent the clutch from escaping from its position in the lamp and causing inconvenience in trimming.

A further object is to so suspend an arc-inclosing globe that it shall be elastically sup-

ported against its seat without producing objectionable shadows and yet be very convenient for removal in trimming.

A further object is to provide improved means for supporting the outer globe and to so construct said means that they will be adaptable to globes of different sizes, be capable of being readily attached to and detached from the globe, and which shall not be liable to break the globe on account of expansion and contraction of the glass.

A further object is to permit adequate ventilation and at the same time exclude rain and insects.

A further object is to so construct the bottom of the lamp-casing that it shall serve also as a reflector to eliminate shadows in the lower portion of the globe.

A further object is to improve and simplify the construction and arrangement of an electric-arc lamp and to produce an arc-lamp which will successfully burn with the use of an alternating current.

With these objects in view the invention consists in various 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 a view in elevation of my improved lamp with the door open. Fig. 2 is a longitudinal sectional view of the lamp, partly in elevation. Figs. 3, 4, and 5 are enlarged views of a portion of the lamp, showing the clutch and cooperating parts. Fig. 6 is a horizontal sectional view. Figs. 7 and 8 are detailed views of the globe-holders. Figs. 8 and 9 are detail views of the upper-carbon holder.

Heretofore in the construction of the casings which inclose the regulator of electric-arc lamps various metals have been employed, but much difficulty has been experienced in constructing a casing which will be sufficiently substantial to properly support the parts of the regulator and prevent the derangement thereof (especially when the lamps are used with alternating currents) and at the same time not be open to objection of weight and liability to be seriously affected and rendered practically useless by the action of varying temperatures and by moisture. Steel and iron have been employed; but these



metals are liable to rust. Brass is liable, in many sections of the country, to become cracked, while aluminium and zinc are not of uniform strength and of sufficient rigidity for the purpose. Copper is the most desirable metal for use in making the casings, but has the objection urged against it that it can be easily bent and result in throwing the mechanism of the lamp out of line, and thus impairing the proper operation of the lamp.

To overcome the various defects and objectionable features incident to lamp-casings as heretofore constructed, I propose to make a casing of sheet-copper and to so form it that it shall possess maximum rigidity, serve to support the heaviest parts of the lamp mechanism, and be capable of withstanding any tendency of the casing to bend. To this end the sheet-copper casing A of the lamp is made in sections and is circular, (in cross-section,) so that every portion will be curved, and each section is formed with a number of vertical ribs 1. The lower portion of the casing is flared outwardly and fluted, as at 2. The upper end of the body of the casing is also made somewhat flaring and provided at its upper edge with an outwardly-projecting annular flange 3, on which a stout ring 4 is permanently secured, said ring having depending flanges 5 at its edges, between which the flange 3 is disposed. A hood 6, made of fluted or ribbed sheet-copper, is mounted on the ring 4, said hood being provided with a peripheral flange 7, which rests upon the ring 4 and is secured thereto by means of screws 8. The hood 6 serves to inclose and also to support an induction resistance 9, which is secured thereto by means of screws 10. A portion of the body of the casing is hinged to form a door to permit access to the working parts of the mechanism, but it is sometimes desirable and often necessary to render the casing more accessible than the provision of a door can afford. By mounting the hood removably on the fixed ring 4 it can be readily removed without disturbing the regulating and controlling mechanism of the lamp, and thus access to the upper parts of said mechanism and also to the resistance secured within the hood can be had for purposes of inspection, cleaning, repair, or renewal of parts.

The floor 12 consists of a plate or sheet of aluminium having a depending peripheral flange 13 and is securely riveted to the flaring lower end of the casing. The spaces 14 (formed by the fluted lower end of the casing) and the flange 13 of the floor 12 serve to admit air for ventilating purposes, but will not, on account of the flaring formation of the bottom of the casing, permit the entrance of water. Insects are prevented from finding their way into the casing through the openings 14 by means of a strip 15 of perforated sheet metal placed in the lower end of the casing. Air entering the spaces or openings 14 will be permitted to circulate about the mechanism within the casing and can escape through

a hole 16 in the hood 6. The hole 16 is covered by means of a cap 17, (having recesses 18 to permit the passage of air,) rigidly secured to the head, and this cap is provided with lugs 19, between which an insulator is secured for the attachment of any suitable means for suspending the lamp.

As previously stated, the floor 12 is made of aluminium, and it serves also as a cover for the outer globe 19, the aluminium being bright, serving as a reflector to eliminate shadows in the lower portion of the globe.

In constructing the holder for the large or outer globe 19 I employ a band 20, of sheet-copper, which is bent to form beads 21 to add strength thereto and having a larger intermediate bead 22 to be disposed under the flange 23 of the globe. The band 20 is also made with a number of fingers 24, adapted to embrace the lower portion of the globe. The ends of the band are made to overlap, and one end is provided with a finger 24<sup>a</sup>, having a series of screw-threaded holes. A plate 25 is secured to the band near its other end and made with a hole (or holes) for the passage of screw 26, which enters one of the holes in the finger 24<sup>a</sup>, and thus secure the ends of the band together and the band on the globe. By thus constructing the band 20 it can be readily adapted to globes of different sizes, and being made of sheet-copper it will possess sufficient flexibility to avoid the breaking of the globe on account of varying degrees of temperature. The band 20 is provided at one point with a rigid hook or tooth 27 to enter a loop 28, depending from the lamp-casing. At a diametrically opposite point on the band a toothed arm 29 is secured thereto and is adapted to be engaged by an arm or loop 30, pivotally attached to the casing. The loop 30 is elongated laterally in both directions from its pivotal support, so that it can be swung laterally to permit the ready detachment of the toothed arm therefrom. A chain 31 is secured at one end to the band in close proximity to the hook or tooth 27 and at the other end to the casing, said chain serving to suspend the globe when the lamp is being trimmed.

Two arms or hangers 32 depend from the floor 12 and at their lower ends support a cover 33 for the inner arc-inclosing globe 34. The inner globe 34 is maintained with a yielding pressure against its seat by means of a conical convolute spring 35, made, preferably, of flat spring metal, which bears at its larger end against the bottom of the globe. The apex of the conical spring is secured to a yoke 36, to the respective ends of which wires 37 are attached. The other ends of said wires are loosely connected with lugs 38, projecting from the cover 33 of the arc-inclosing globe. By thus supporting the globe 34 it can be readily removed when the lamp is to be trimmed, and when in use does not produce objectionable shadows.

A rod 38 is secured to and depends from

the inner globe-cover 33 and is provided at its lower end with a lower-carbon holder 40, the lower-carbon holder and its support being thus disposed within the arc-inclosing globe.

5 One of the arms or hangers 32 is electrically connected with the cover 33, (which latter is electrically connected with the lower-carbon holder,) and said arm or hanger is connected by means of a conductor 41 with one terminal of the regulator-magnet or solenoid 42.

10 The other terminal of the solenoid is connected with one terminal of the resistance 9, the other terminal of the resistance being connected with the minus terminal of the lamp, as hereinafter more fully explained.

15 The magnet or solenoid 42 is disposed between two plates 43 44, which are secured to the sheet-metal body of the lamp-casing, (preferably by means of screws,) and said plates are connected by rods or bolts 45, which serve to clamp the magnet or solenoid in place between the plates, and between the magnet or solenoid and clamping-plates felt or asbestos is placed for taking up vibrations.

20 The upper plate 43 is provided with an upwardly-projecting arm 46, provided at its free end with a boss, in which a walking-beam 47 is mounted. One arm of the walking-beam is connected with the core 48 of the solenoid through the medium of a spring 49, and to the other arm of the walking-beam a rod 50 is pivotally attached. The lower end of the rod 50 is secured to a bar or lifter 51, which passes freely through a hole in the floor of the casing and is provided at its lower end with a hook 52, adapted to grasp the flanged periphery of a clutch-ring 53. The clutch-ring is disposed above a tubular extension 54 on the inner globe-cover 33, and into said tubular extension a porcelain or lava bushing 55 is screwed. When the lamp is not burning, the clutch-ring rests on the bushing, and the upper carbon 56 of the lamp passes loosely through it. The upper carbon is guided within the casing A in a tube 57, the upper end of which is supported in a proper upright position by an insulating-disk 58, located at the lower end of a rod 59, secured to and depending from the cap on top of the hood of the casing.

50 The lower end of the tube 57 is removably secured by means of a screw 60 to a plate 61, secured in the bottom of the casing. Thus it will be seen that by removing the hood and cap from the casing and withdrawing the screw 60 the carbon-guiding tube can be readily removed. With lamps employing guiding-tubes for the upper carbon it has heretofore been customary to employ a sliding contact for the upper carbon. This is objectionable in a lamp operating with an alternating current, as it is important to reduce the number of movable devices to a minimum on account of the violent vibrations incident to lamps employing alternating currents. I propose, therefore, to connect the flexible conductor 62 directly to the holder 63 of the upper carbon, and this holder being disposed within the tube the latter is provided with a slot 64 for the accommodation of the connection between said conductor and holder. It has heretofore been proposed to construct a carbon-holder of a section of tubing and making a series of two or more longitudinal slots in the lower end thereof, whereby to form spring-jaws to receive the end of the carbon-rod. With such construction the grain of the metal does not run in a direction to insure the best results, and hence the spring-jaws have not as much strength or grasping qualities as they would have if the grain of the metal were made to run in a direction parallel with the longitudinal axis of the jaw, and hence the spring-jaws when formed by slotting the lower end of a tube are liable to become strained and weakened when subjected to the violent vibrations of an alternating-current arc-lamp. In constructing my improved carbon-holder I employ spring metal and so arrange the same that the grain of the metal will run parallel with the axis of the jaws. A strip of spring metal is bent in approximately circular form (with the ends slightly separated, as at 63<sup>a</sup>) for the reception of the end of the carbon-rod. One edge of the strip is cut to form two fingers 64<sup>a</sup>, which are bent one upon another to form a socket for the reception of a small projection 65 on a cylindrical block 66, to which the holder is secured by means of a screw 67. The block 66 is adapted to slide within the tube 57 and is preferably covered by a packing-ring 68, of non-sonorous material. The upper end of the cylindrical block is provided with a lug 69, to which the conductor 62 is electrically connected. The other end of the flexible conductor 62 is electrically connected with an insulated shoe 68, carried by a switch-arm 69, the latter being mounted in the upper portion of the lamp-casing and provided (exteriorly of the casing) with a crank-arm 70. The shoe of the switch-arm is adapted to engage contact-arms 71, attached to a bracket 72, secured to the core of the inductive resistance 9. The bracket 72 serves as a binding-post for the plus leading-in wire. The minus leading-in wire is connected with a similar bracket or binding-post 73, also secured to the core of the resistance, and the binding-post 73 is connected by a suitable conductor 74 with a terminal of the inductive resistance. The upper portion of the lamp-casing is provided with porcelain sleeves for the passage of the leading-in wires.

120 The connections of the lamps may be readily traced from the plus bracket or connector 72 to the upper-carbon holder 63 by the switch and the conductor 62, through the carbons and lower-carbon holder to the cover of the arc-inclosing globe, thence to one of the arms or hangers 32, and then by conductor 41 to one terminal of the helix of the solenoid, and from the other terminal of the solenoid to the

one terminal of the resistance, and from the other terminal of the resistance to the minus binding-post 73.

As has been previously stated, electric-arc lamps when operated with alternating currents are subjected to violent vibrations of the parts, and for this reason much difficulty and annoyance have been experienced by the upper carbon "shaking through" the clutch. Attempts have been made to overcome this defect by the use of springs; but as springs are quite susceptible themselves to receive and transmit vibrations, and hence their use has not resulted in successfully preventing the carbon from shaking through the clutch, I overcome this defect by offering to the clutch-ring when it grasps the carbon a dead resistance. The dead resistance or weight may be applied to the clutch in various ways; but I prefer to utilize for the purpose stated the plunger of the air-pot without detracting in the slightest degree from the efficiency of the air-pot in the performance of its functions of steadying the operation of the regulating and controlling mechanism of the lamp. For the accomplishment of the purpose of my invention it is a matter of considerable importance that the air in the air-pot be partially compressed before the clutch becomes active to raise the carbon, so that when the carbons separate to establish the arc the vibrations of the clutch will be effectually resisted by a substantial cushion of compressed air in the air-pot. The bar or lifter 51, secured to the lower end of rod 50, as hereinbefore described, is made with a hole in which a short rod 75 is disposed and guided, said rod normally resting on the clutch-ring. The bar 51 being connected with the ring-clutch, it is apparent that any weight which is brought to bear on the rod 75 will be transmitted directly to said clutch-ring and serve to prevent the same from vibrating, and thus prevent the carbon from shaking through it during the operation of the lamp. The upper end of the short rod 75 is pivotally attached between the ends of a lever 76. One end of the lever 76 is pivotally supported by an arm 77, projecting upwardly from the plate 61 in the bottom of the lamp-casing. The other end of the lever 76 is attached to the plunger-rod 78 of an air-pot 79, and the latter is suspended from an arm 80, secured to the tube 57. From this construction and arrangement of parts it will be seen that the air-pot will perform its usual functions of steadying the regulating and controlling mechanism, and the plunger will offer a resistance, and thus apply a weight to the clutch-ring and serve effectually to prevent the vibration of the latter.

When current enters the lamp, the solenoid will draw its core down, lift the clutch-rod, and cause the clutch-ring to be tipped and made to clutch the carbon and lift it to establish the arc. It may be here stated that in lamps using an alternating current one of the carbons is usually cored, and when the

lamp has just been trimmed the core is apt to produce a flaming arc, and thus renders it necessary that the arc be abnormally long to prevent the rise of current to a point that would cause the heat to break the inner globe. With my construction the mechanism is capable of drawing an arc approximately double the ordinary length, thus effecting a great saving of inner globes that would otherwise be cracked from excessive heating when the lamp is started with new carbons. As the carbons consume, the resistance of the arc increases, current decreases, the solenoid loses strength, and the weight of the clutch and carbon, with attached parts, overcome the pull of the solenoid and descend slowly until a time is reached when the clutch rests upon its trip—viz., the lava or porcelain bushing screwed into the cover of the inner globe. A further descent of the clutch and rod releases the clutch from the carbon by permitting the clutch to assume a horizontal position, when the carbon will feed through it. This diminishes the resistance of the arc, the current increases in strength, enabling the solenoid to again draw down its core with greater force, and the carbons will be again drawn apart.

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

1. In an electric-arc lamp, the combination with a clutch-ring, a lifter connected with said clutch-ring at one side of the carbon, a pivoted lever, a rod connected with said lever at a point between the ends of the latter and resting on the clutch-ring at the same side of the carbon as the connection of the lifter with said clutch-ring and an air-pot having its plunger connected with the free end of said pivoted lever whereby when the lifter is actuated air will be compressed in the air-pot before the clutch raises the carbon.

2. In an electric-arc lamp, the combination with the clutch and lifter, of a weight applied to the clutch at the same side thereof as the attachment of the lifter thereto and operating independently of the lifter.

3. In an electric-arc lamp, the combination with a carbon-rod, a ring-clutch and a lifter, of a weight applied to said ring-clutch independently of the lifter and at the same side of the clutch as the attachment thereto of the lifter.

4. In an electric-arc lamp, the combination with the upper carbon, a clutch and regulating mechanism connected with the clutch, of means for applying dead resistance to said clutch at the side thereof to which the regulating mechanism is attached and independently of said regulating mechanism, to prevent the carbon from shaking through said clutch.

5. In an electric-arc lamp, the combination with the upper carbon, a clutch and regulating mechanism connected with the clutch, of weight, and means for applying said weight to the clutch at the side thereof to which the

regulating mechanism is attached, when the clutch is raised by said regulating mechanism.

6. In an electric-arc lamp, the combination with the upper carbon, a clutch, a magnet and a lifter connected with the clutch and magnet, of an air-pot and a connection between the plunger of the air-pot and the clutch, said connection bearing against the clutch at the side thereof to which the lifter is connected and independently of said lifter.

7. In an electric-arc lamp, the combination with the clutch, an electromagnet, intermediate connections between the clutch and magnet, of an air-pot having its plunger connected with said intermediate connections, and a connection between said plunger and clutch and bearing against the latter at the side thereof to which said first-mentioned connections are attached and independently of said first-mentioned connections.

8. In an electric-arc lamp, the combination with the clutch and the regulator-magnet, of an air-pot having its plunger connected with said regulator to steady the movement thereof, said plunger also having an independently-operating connection with the clutch to apply a dead resistance or weight thereto, substantially as set forth.

9. In an electric-arc lamp, the combination with the clutch and the regulator-magnet, of a clutch-rod connected with the armature of said magnet, a clutch-bar secured to said rod and connected with the clutch, a pivoted lever, a rod attached to said lever and guided in a socket in said clutch-bar and an air-pot having its plunger connected with said pivoted lever, substantially as set forth.

10. In an alternating-current electric-arc lamp, the combination with the clutch and the regulator-magnet, of a walking-beam, a spring connecting one arm of the walking-beam with the armature of the magnet, a clutch-lifter connected with the other arm of the walking-beam and connected with the clutch, and an air-pot, a rod connected with the plunger of the air-pot, said rod guided by the lifter and connected independently with the clutch so as to apply dead resistance therein.

11. In an electric-arc lamp a casing comprising a body of ribbed sheet metal having an outwardly-projecting flange at its top, a stout ring secured upon said flange, and a sheet-metal ribbed or corrugated hood removably secured upon said ring.

12. In an electric-arc lamp, the combination with a vertically-disposed casing, regulating mechanism therein, and a depending lamp-arm provided with a lower-carbon holder, of a guide-tube disposed vertically within the casing provided with a longitudinal slot, an upper-carbon holder movable within said tube, and a flexible conductor connected at one end with a terminal of the lamp and connected at its other end to the upper-carbon holder through the slot in the guide-tube, substantially as set forth.

13. The combination with a casing having a removable cover or hood, of a carbon-guiding tube removably secured at its lower end to the bottom of the casing, a rod depending within the removable hood and entering the carbon-tube and a head on the lower end of said rod, substantially as set forth.

14. The combination with a lamp-casing and a globe adapted to seat against the bottom of the casing, of an adjustable band encircling the upper end of the globe, a hook and a toothed arm projecting from said band, a fixed loop on the casing to receive said hook and a loop pivoted to the casing and made elongated laterally from its pivotal support and adapted to engage said toothed arm.

15. The combination with a lamp-casing and a globe, of a sheet-metal corrugated band encircling the upper end of the globe, means for adjustably securing the ends of the band together and means for adjustably and removably securing the band to the lamp-casing to support the globe, substantially as set forth.

16. The combination with a lamp-casing and a globe, of a sheet-metal corrugated band adapted to encircle the upper end of the globe and having overlapping ends adjustably secured together, hooks projecting from said band and detachably connected with the casing, a chain connecting said band with the casing, a toothed arm projecting from the band and a loop pivoted to the casing and adapted to engage said toothed arm, substantially as set forth.

17. A carbon-holder consisting of sheet metal bent across the grain of the metal to circular form with the free ends of said circular strip separate from each other, whereby the clutch will consist of two integral members having the metal running longitudinally thereof in a horizontal direction.

18. A carbon-holder consisting of a strip of spring metal bent to embrace the carbon and having fingers bent to form a socket, and a block having a portion secured within said socket.

19. In an electric-arc lamp, the combination with a carbon-guiding tube, of a metal block having a non-sonorous covering within said tube, and a carbon-holder secured to said block, said carbon-holder consisting of a strip of spring metal bent to embrace the carbon and having fingers bent to form a socket to receive a portion of said block, substantially as set forth.

20. A sheet-metal electric-lamp casing having a fluted lower end and a bottom secured within said fluted end so as to form a series of air-inlets and a perforated strip covering said inlets, substantially as set forth.

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

THOMAS EDGAR ADAMS.

Witnesses:

T. F. BEINLER,  
JOHN D. ERTEL.

No. 644,563.

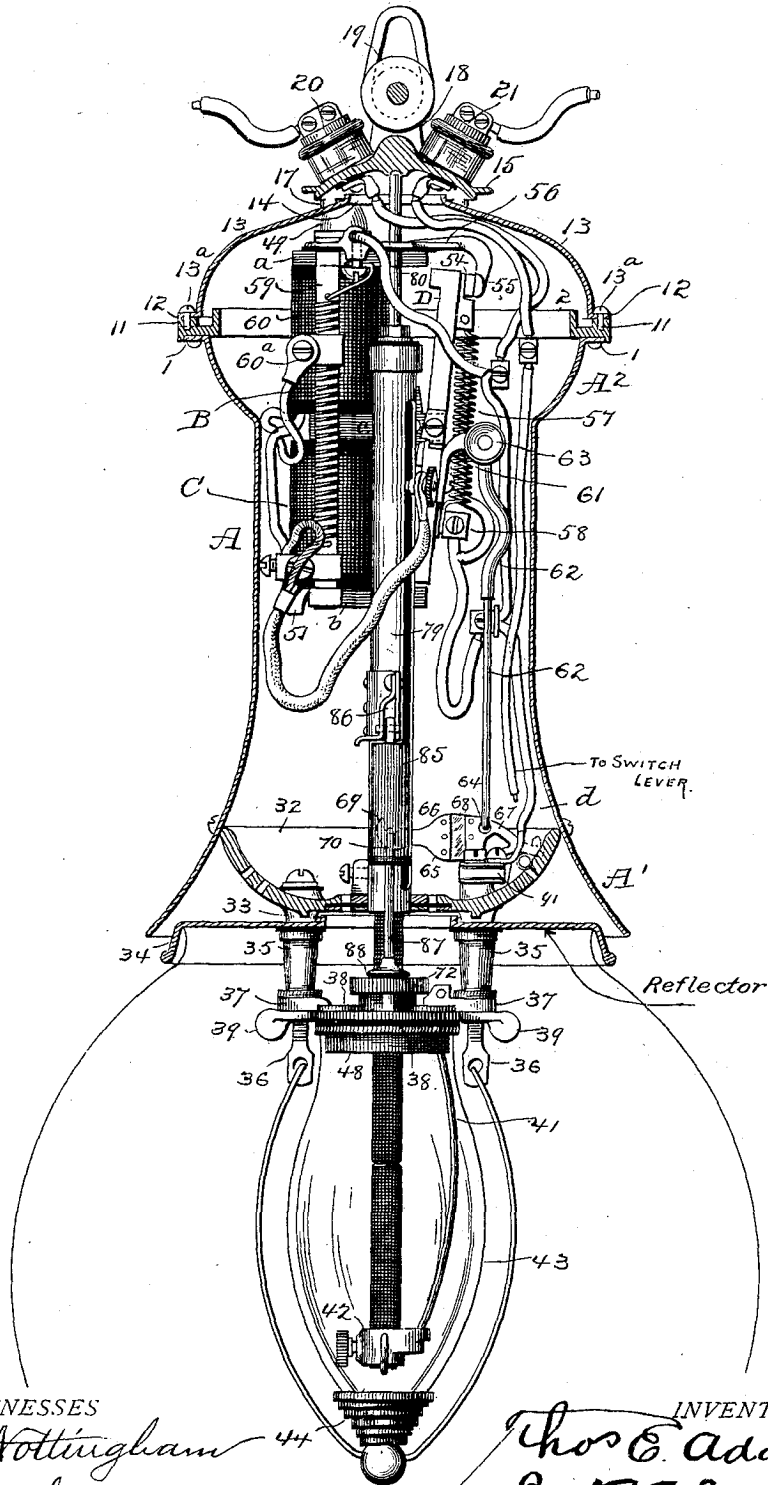
Patented Mar. 6, 1900.

T. E. ADAMS.  
ELECTRIC ARC LAMP.

(Application filed Sept. 20, 1899.)

(No Model.)

4 Sheets—Sheet 1.



WITNESSES  
*E. J. Nottingham* 44  
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T. E. ADAMS.  
ELECTRIC ARC LAMP.

(Application filed Sept. 20, 1899.)

(No Model.)

4 Sheets—Sheet 2.

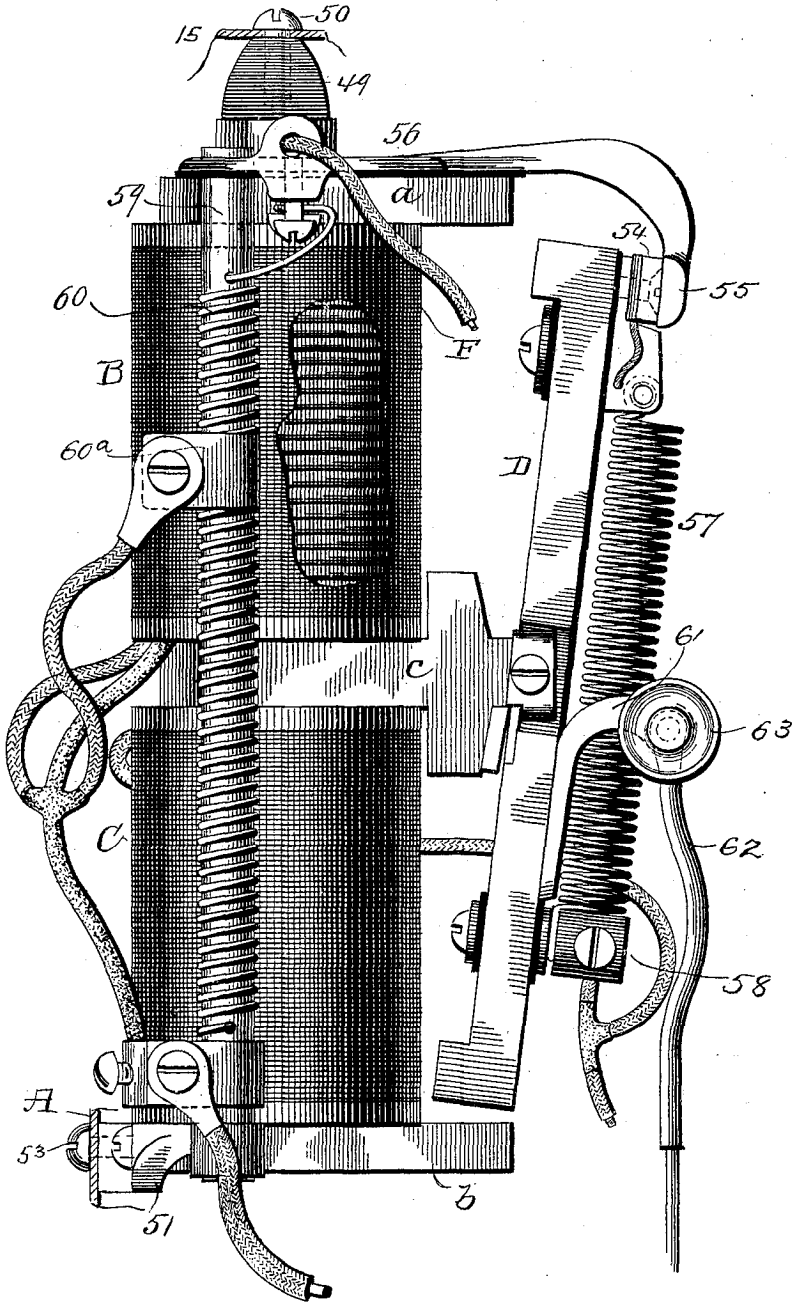


Fig. 2

WITNESSES  
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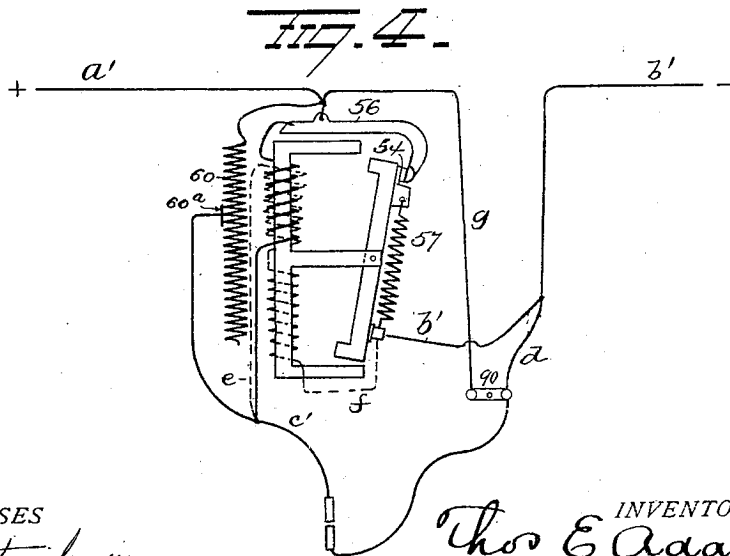
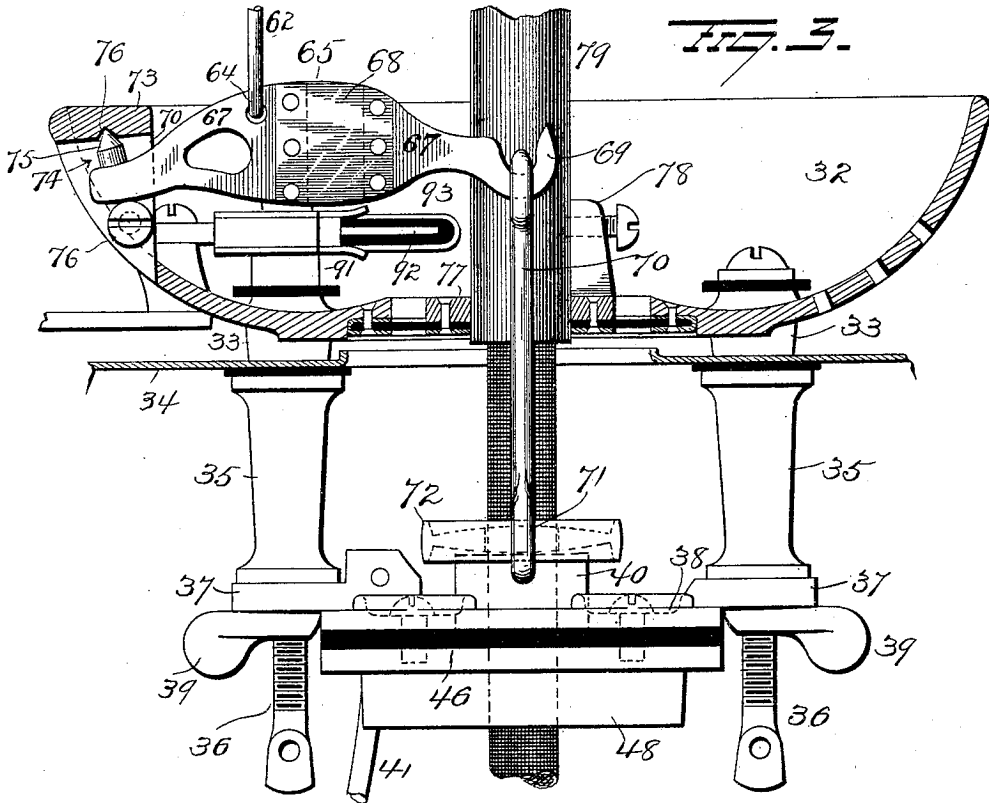
Patented Mar. 6, 1900:

T. E. ADAMS.  
ELECTRIC ARC LAMP.

(Application filed Sept. 20, 1899.)

(No Model.)

4 Sheets—Sheet 3.



WITNESSES  
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ELECTRIC ARC LAMP.

(Application filed Sept. 20, 1899.)

(No Model.)

4 Sheets—Sheet 4.

FIG. 5.

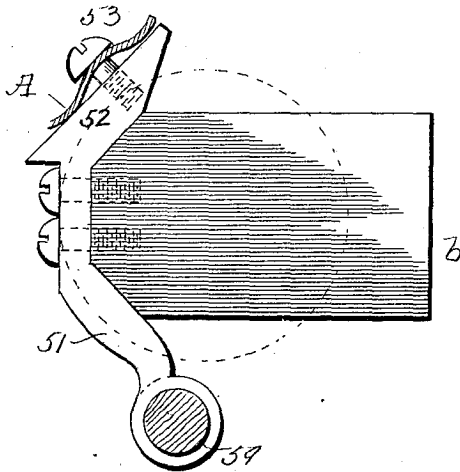
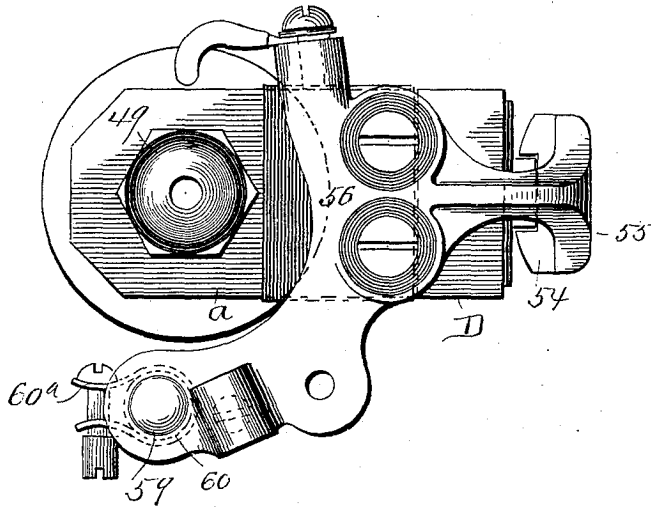


FIG. 6.

WITNESSES

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*G. F. Downing*

INVENTOR

*Thos E. Adams*  
*By B. A. Seymour* Attorney



# UNITED STATES PATENT OFFICE.

THOMAS EDGAR ADAMS, OF CLEVELAND, OHIO.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 644,563, dated March 6, 1900.

Application filed September 20, 1899. Serial No. 731,123. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS EDGAR ADAMS, 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 electric-arc lamps; and it consists in certain 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 with the casing shown in section. Fig. 2 is an enlarged view of the regulator-magnets and attached parts. Figs. 3, 4, 5, and 6 are views illustrating various details.

A represents the lamp-casing, made, preferably, of corrugated sheet-copper, circular in cross-section and having a flaring lowering end  $A^1$  and a flaring upper end  $A^2$ . The upper edge of the portion  $A^2$  of the casing is provided with an outwardly-projecting annular flange 1, which constitutes a seat for a stop-ring 2, preferably of cast metal. The ring 2 is made angular in cross-section. The horizontal portion of the ring 2 is provided with a series of bosses 11, on which a peripheral flange 12 on a hood 13 rests and to which said flange is secured by means of a series of screws 13<sup>a</sup>. By securing the flange of the hood to the bosses on the ring 2 spaces will be left between said flange and ring for the admission of air, the admission of water being effectually prevented by the vertical flange 3 on said ring. The hood 13 is provided in its top with an opening 14, and over this opening a cap 15 is disposed. The cap 15 is provided on its under edge with lugs 17, which rest on the hood and form spaces between said cap and hood for the admission of air, and through said lugs fastening devices pass for securing the cap in place on the hood. The cap is provided with uprights 18 for the accommodation of an insulator 19 for the reception of means for suspending the lamp. Binding-posts 20 21 are secured to and insulated from the cap at respective sides of the

insulator 19 for the accommodation of the leading-in wires.

A perforated basin 32 is located within the casing, near the bottom thereof, and is secured at its periphery thereto. The basin is provided on its bottom with lugs 33, to which a reflector 34 is secured, said reflector also constituting a cover for the outer globe. Two depending arms 35 are secured to the basin and depend below the reflector 34, said arms being provided in their lower ends with threaded sockets for the reception of screws 36. The screws 36 pass through lugs or ears 37 at diametrically-opposite sides of a circular plate 38, and beneath said ears thumb-nuts 39 are disposed on the screws for the purpose of supporting the plate 38 and also for securing the screws at different adjustments for a purpose which will be hereinafter made apparent.

The plate 38 is made with a central opening for the passage of a boss 40 of plate 46, through which passes the upper carbon of the lamp and which constitutes a stop or rest for the clutch-ring of the lamp.

A depending rod 41, constituting the lamp-arm, is secured to and electrically connected at its upper end with the plate 38, and at the lower end of said rod or lamp-arm 41 a holder 42 for the lower carbon of the lamp is secured.

An inner globe 43 incloses the lamp-arm 41 and the arc. The globe 43 may be made approximately oval in general form and having its lower contracted end closed and its upper end open. The lower contracted end of the globe 43 rests in the upper end of a conical convolute spring 44, and the latter is secured at its lower end centrally between the ends of a wire yoke 45. The upper ends of the arms of the yoke are pivotally attached to the lower ends of the screws 36, and by means of these screws the tension of the spring, and consequently the pressure of the open upper end of the globe against its cover, can be readily adjusted. The cover for the arc-inclosing globe consists of an iron plate 46, secured to the plate 38 and insulated therefrom by means of a disk 47, preferably of asbestos. The plate or cover 46 is provided with an annular flange 48, which depends into the globe and serves to conduct heat from the inner

face thereof at its open end for the purpose of reducing liability of the globe to break on account of the unequal temperatures of the inner and outer faces thereof.

5 Regulator-magnets B C are disposed within the upper part of the casing and provided with a common core having salient poles *a b* and a consequent pole *c*. To the upper end of the magnet-core a knob 49, of brass or other  
10 non-magnetic material, is secured, and said knob is rigidly attached to the cap 15 by means of a screw 50, the magnets being thus suspended from said cap. A bar 51, of brass or other non-magnetic material, is secured to  
15 the lower end of the magnet-core and provided with an enlargement 52, having an elongated face to bear against the inner wall of the body of the lamp-casing, to which it is rigidly secured by means of a screw 53.  
20 Thus the magnets and attached parts are firmly supported and the rigidity of the casing enhanced. The consequent pole of the magnet-core is projected laterally and pivotally supports the armature D at a point mid-  
25 way between the ends thereof, the respective ends of the armature being adapted to be attracted by the respective salient poles. The upper magnet B is of coarse wire and included in the main lamp-circuit and the lower  
30 magnet of fine wire and included in a shunt-circuit around the arc, a portion of the fine wire being preferably wound on the coarse-wire winding of coil B and connected electrically to it. The upper end of the armature D  
35 carries a shoe 54, adapted to normally make contact with an arm 55, projecting from a plate 56, secured upon and insulated from the upper pole-piece of the magnet-core. A coil  
40 57 of resistance-wire is attached at its upper end to the shoe 54 and at its lower end to a binding-post 58, secured to and insulated from the armature, said coil being included (when the lamp is not burning) in a shunt-circuit around the magnets, as shown in the  
45 diagrammatical view. The plate 56 also supports the upper end of a rod 59, of wood or other non-conducting material, the lower end of said rod being secured to the bar 51. A resistance-coil 60 is coiled on the wooden rod  
50 59 and electrically connected at one end to the plate 56, to which latter the plus terminal of the lamp and one terminal of the coarse-wire coil are also connected.

An arm 61 is secured to the armature D and  
55 projects outwardly therefrom at or near the fulcrum thereof. The free outer end of the arm 61 is bifurcated for the reception of the upper end of the clutch-rod 62, which is pivotally attached thereto by means of a thumb-  
60 screw 63. The lower end of the rod 62 is provided with a hook 64, loosely connected to a lever 65 at a point between the ends of the latter. The lever 65 comprises two metal sections 66 67 and an intermediate section 68,  
65 of insulating material, (such as mica,) separating the metal sections. The free end of the section 66 of the clutch-lever is provided

with a hook 69, which engages the upper end of a clutch-lifter 70, the latter passing freely through the bottom of the basin and the reflector or globe-cover and provided at its  
70 lower end with a hook 71, which engages the flanged periphery of the clutch-ring 72. The wall of the basin is made with an inwardly-projecting enlargement 73, (forming a recess  
75 74 in the exterior of said basin,) and said enlargement is slotted for the free passage of the outer end of section 67 of the clutch-lever 65. The outer end of section 67 of the lever terminates within the recess 74 and is  
80 provided on its upper face with a pointed or conical pin 75, having a bearing in a similarly-shaped socket 76 in the roof of the recess 74. A screw 76 is passed through a wall  
85 of the recess 74 and provided with a head located within said recess and disposed under the end of the clutch-lever, so as to prevent the displacement thereof.

By mounting the lever 65 as above explained friction is reduced to a minimum,  
90 and by the use of said lever a slight movement of the armature will cause a greater movement of the clutch-ring, and thus insure the proper operation of the clutch-ring should the hole therein become worn or should it be  
95 desired to employ a smaller carbon than the ring was originally intended to operate.

An insulated plate 77 is secured within the opening in the bottom of the basin and provided with a lug 78, to which the lower end  
100 of a slotted guide-tube 79 is secured. The upper end of the guide-tube is provided with a rod 80, which passes loosely through a hole in the plate 56, and thus the guide-tube is held securely in proper position. A holder  
105 for the upper carbon moves freely within the tube 79 and is provided with a head of graphite to reduce friction to a minimum.

An air-pot 85 is loosely attached to a bracket 86, secured to the guide-tube, and the rod 87,  
110 connected with the plunger of said air-pot, passes down freely through the basin and reflector. The lower end of the rod 87 is provided with a head 88, which rests upon the clutch-ring at the side thereof opposite the  
115 connection of the lifter therewith, so that the retarding action of the air-pot will come directly on the clutch, and thus serve to assist in the accurate operation of the latter and at the same time prevent the sudden pull of the  
120 magnets and the consequent too-sudden separation of the carbons.

Referring to the diagrammatical view, it will be observed that the normal circuit when the lamp is not burning is from the positive  
125 pole of the lamp by the conductor *a'* to the plate 56, thence through the shoe 54 to the resistance 57 on the armature, and thence by wire *b'* to the negative terminal of the lamp. Sufficient current will pass through the coarse-  
130 wire magnet to cause it to be actuated to separate the carbons, and the working circuit through the coarse-wire magnet may be traced as follows: from the positive pole of the lamp

by the wire *a'* to the plate 56, thence through the coarse-wire coil B, and thence by wire *c'* to the upper carbon of the lamp, thence to the lower carbon, and thence by wires *d* and *b'* to the negative terminal of the lamp. As soon as the coarse-wire coil is energized the armature will be moved to separate the carbons, as is readily understood, and the circuit through the resistance 57 will be broken.

A small amount of current may, however, be shunted around the coarse wire through a portion of the resistance 60, according to the adjustment of the shoe 60<sup>a</sup>. When the resistance of the working circuit increases by the lengthening of the arc, current will be shunted through the fine-wire coil to effect the feed of the carbon, as is well understood. The fine-wire shunt may be traced from the positive pole of the lamp by the wire *a'* to plate 56, then through a portion of the resistance 60, thence to the wire *c'*, thence by wire *e* to the fine-wire coil, thence by wire *f* to wire *b'*, and thence to the negative terminal of the lamp.

A cut-out switch 90 is preferably provided and consists of a shoe 91 and a lever 92, the latter having an insulated plate 93, to which a conductor *g* is attached, the other end of said conductor being connected with the positive terminal of the lamp. The shoe 91 is connected with the negative terminal of the lamp and the lower carbon by means of the wire *d*.

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

1. In an electric-arc lamp, the combination with a magnet-coil in the main lamp-circuit, of a shunt-circuit around said coil and including a resistance, a circuit-breaker controlled by the armature of the magnet and included in said shunt-circuit and a constantly-closed shunt-circuit around the magnet-coil and including a variable resistance.

2. In an electric-arc lamp, the combination with a magnet-core having salient poles and a consequent pole, a coarse-wire winding on said core at one side of said consequent pole, a fine-wire winding on the core at the other side of said consequent pole, a portion of said fine-wire winding being wound on the coarse-wire coil and an armature pivotally mounted between its ends on the consequent pole and adapted to be actuated by the salient poles.

3. In an electric-arc lamp, the combination with a casing and a hood, of a magnet secured to the hood, a bar secured to the lower end of the magnet and to the casing, a plate secured to the top of the magnet and having an arm and connected with a lamp-terminal, a resistance supported by said bar and plate, an armature for the magnet, a shoe on said armature and a resistance carried by the armature, one end of said resistance connected

with said shoe and the other end connected with a terminal of the lamp.

4. In an electric-arc lamp, the combination with a regulator-magnet and its armature, of a clutch-ring, a lifter therefor, a lever comprising two metal sections and an intermediate section of non-conducting material, the free end of one of said metal sections pivotally mounted in the frame of the lamp and the free end of the other metal section loosely connected with the lifter, and a rod attached at its upper end to the armature of the regulator-magnet and connected at its other end with said sectional lever at a point between the ends of the latter.

5. In an electric-arc lamp, the combination with a frame, a regulator-magnet and its armature, of a clutch-ring, a lifter therefor, a lever, an upwardly-projecting conical pin at one end of said lever, the frame having a bearing for said conical pin, a supporting device under the end of the lever having the conical pin, a loose connection between the other end of said lever and the lifter, and a rod attached at one end to the armature of the regulator-magnet and at the other end to said lever at a point between the end of the latter.

6. In an electric-arc lamp, the combination with a regulator-magnet and its armature, of a clutch-ring, a lifter therefor, connections between said lever and the armature of the magnet, an air-pot in the lower part of the lamp and a rod projecting downwardly from the plunger of said air-pot and resting on the clutch-ring at the side thereof opposite the connection of the lifter therewith.

7. In an arc-inclosed electric-arc lamp, the combination with a frame, an inner arc-inclosing globe and a cover for said globe, of a vertically-adjustable yoke inclosing the globe and adapted to be swung laterally and a spring fixed upon the bottom of the yoke and constructed to form a socket for the bottom of the globe.

8. In an electric-arc lamp, the combination with a casing and arms or posts depending therefrom and having threaded sockets, of screws entering said sockets and depending therefrom, thumb-nuts for locking said screws, an inner globe, a cover therefor, a yoke embracing the globe and having its ends attached to said screws and a spring carried by said yoke and bearing against the bottom of the globe.

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

THOMAS EDGAR ADAMS.

Witnesses:

T. F. BEIDLER,  
JOHN D. ESTEL.

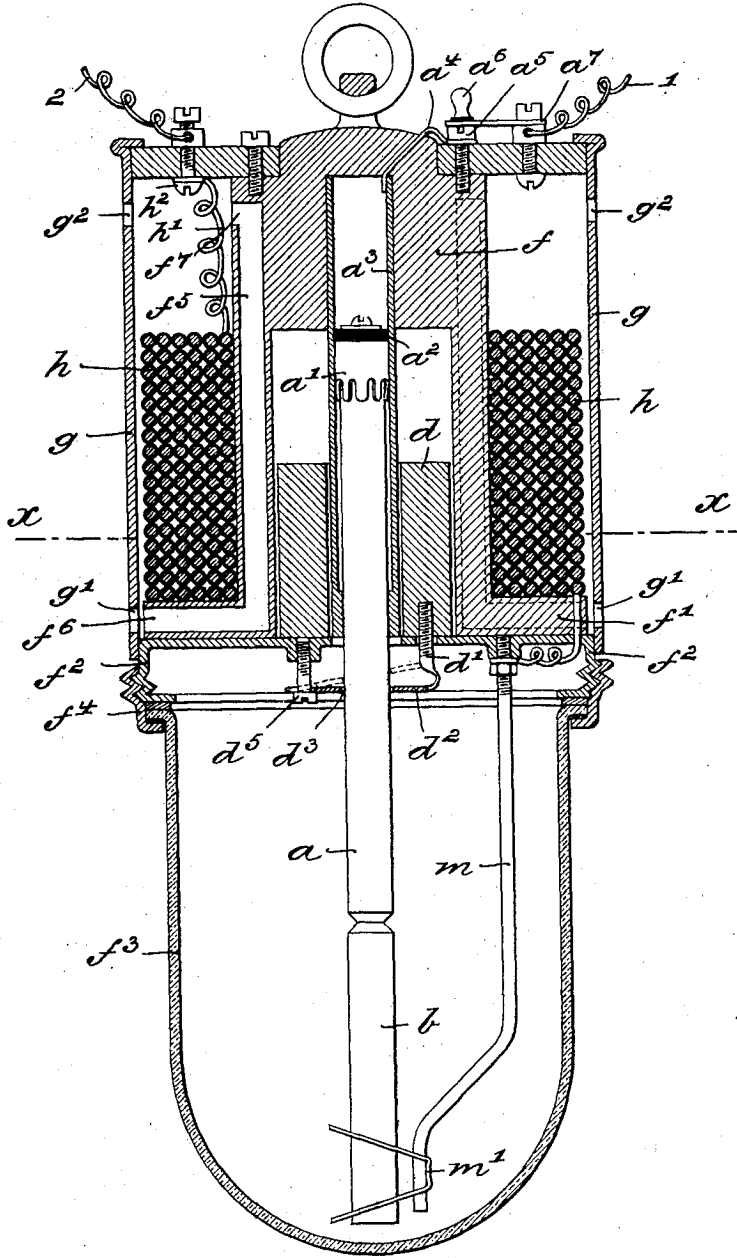
J. A. HEANY.  
ELECTRIC ARC LAMP.

(Application filed Feb. 27, 1900.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 1.



Witnesses:  
 Thomas M. Smith,  
 Richard C. Maxwell

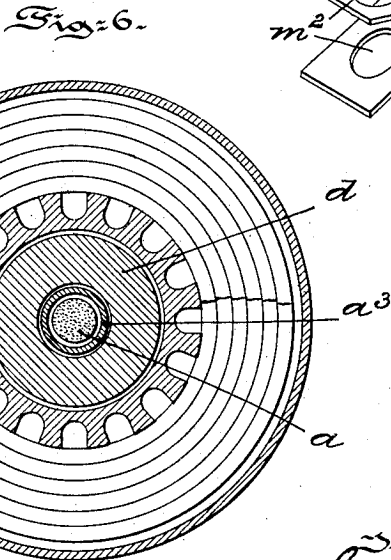
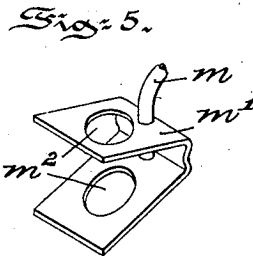
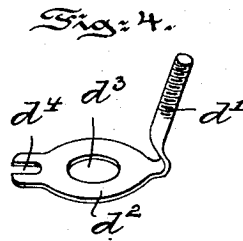
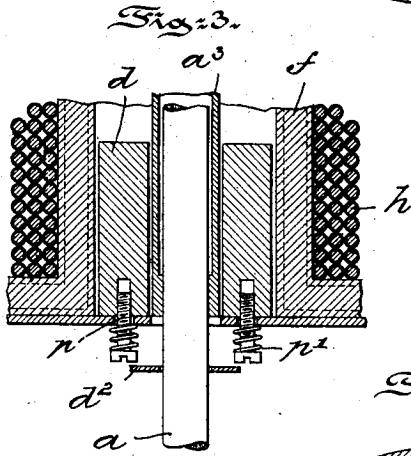
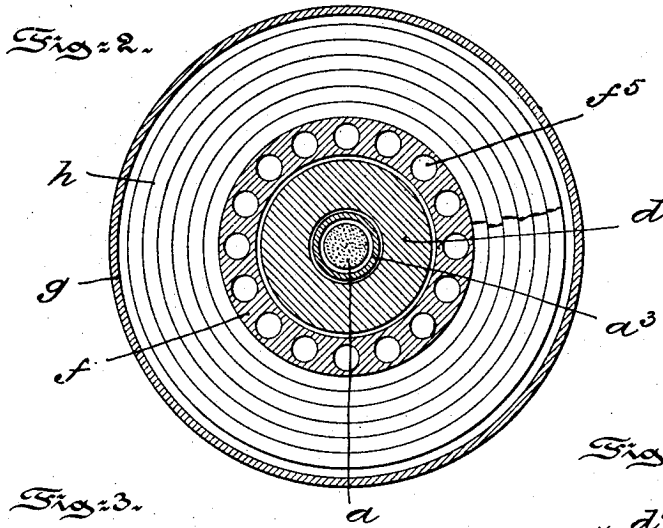
Inventor:  
 John A. Heany,  
 by J. Walter Dwyer  
 Attorney.

J. A. HEANY.  
ELECTRIC ARC LAMP.

(Application filed Feb. 27, 1900.)

(No Model.)

2 Sheets—Sheet 2.



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 Richard C. Maxwell

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# UNITED STATES PATENT OFFICE.

JOHN A. HEANY, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE TETER-HEANY DEVELOPING COMPANY, OF SAME PLACE AND CHARLESTON, WEST VIRGINIA.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 661,126, dated November 6, 1900.

Application filed February 27, 1900. Serial No. 6,659. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN A. HEANY, a citizen of the United States, residing at the city of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

My present invention has relation to an electric-arc lamp and to that particular type of lamp which is illustrated, described, and claimed in a companion application for a patent filed of even date herewith under Serial No. 6,658, series of 1900. In said companion application there are shown, described, and claimed certain generic features of invention, one of which may be briefly described as follows: the location of the carbons, the solenoid-core, and auxiliary working parts in an air-tight receptacle around which is arranged the solenoid-coil. In the present invention this same generic feature is involved; but a different arrangement of the parts, together with other specific details of improvement, forms the subject-matter of this application.

My present invention consists, first, in an improved means of conducting the electric current to the upper carbon; second, in an improved means for feeding said carbon; third, in an improved construction of the inner air-tight receptacle containing the carbons and the working parts, and, fourth, in an improved holder for the lower carbon.

My invention, stated in general terms, consists of an electric-arc lamp constructed and arranged in substantially the manner hereinafter described and claimed.

The nature and scope of my invention will be more fully understood from the following description, taken in connection with the accompanying drawings, forming part hereof, in which—

Figure 1 is a vertical central sectional view of an electric-arc lamp embodying main features of my invention. Fig. 2 is a cross-sectional view taken on the line  $x x$  of Fig. 1. Fig. 3 is a vertical central sectional view of the lower portion of the upper carbon and auxiliaries, said view being taken at right angles to the view illustrated in Fig. 1. Fig.

4 is a detail perspective view of the feeding-clutch for the upper carbon. Fig. 5 is a similar view of the lower-carbon support; and Fig. 6 is a cross-sectional view similar to Fig. 2, but illustrating a modified form of air-tight inner receptacle.

Referring to the drawings,  $a$  represents the upper and  $b$  the lower carbon of the lamp. The carbon  $a$  is held at its upper end in a cap  $a'$ , to which is secured a brush  $a^2$  of highly-conductive material. The cap  $a'$ , brush  $a^2$ , and carbon  $a$  are adapted to slide up and down in a stationary metallic tube  $a^3$ , which is connected by wire  $a^4$ , binding-screw  $a^5$ , switch  $a^6$ , and binding-post  $a^7$  with a pole of the source of electric energy. The brush  $a^2$  serves to always make electrical contact between the tube  $a^3$  and carbon  $a$ , while permitting said carbon to be slid up and down in the tube  $a^3$ . Surrounding the tube  $a^3$  and near its base is a solenoid-core  $d$ . This core  $d$  carries the clutch or feeding mechanism for the upper carbon and is adapted to slide up and down upon the tube  $a^3$  in a box or receptacle  $f$ , in the upper end of which the tube  $a^3$  is secured. This box  $f$  has a flanged base  $f'$ , which is supported upon and fixed to a screw-collar  $f^2$ . To the collar  $f^2$  is clamped a globe  $f^3$  by means of a screw-ring  $f^4$ , said globe inclosing the lower carbon  $b$  and its holder and forming, with the box or receptacle  $f$ , an air-tight compartment inclosing both carbons, the solenoid-core  $d$ , and the necessary auxiliaries for the proper support and feeding of the carbons.

The receptacle  $f$ , as illustrated in Fig. 1, has its tubular walls vertically perforated with flues  $f^5$ , communicating at the base with a series of radially-disposed flues  $f^6$ , and at the upper end with radially-disposed outlets  $f^7$ , opening into the exterior of the box  $f$ . In the modified form illustrated in Fig. 6 the arrangement is the same, except that the outer periphery of the walls of the box  $f$  is vertically channeled, as at  $f^{10}$ . Surrounding the box  $f$  is an outer casing  $g$ , having at its base and top the openings  $g^1$  and  $g^2$ , registering, respectively, with the inlets  $f^6$  to flues  $f^5$  and the outlets  $f^7$  from said flues. In the space between the casing  $g$  and box  $f$  and around

the box is coiled the solenoid-coil  $h$ , connected by wire  $h'$  and binding-post  $h^2$  to the other pole  $2$  of the source of electric energy. This coil  $h$  is formed of a wire of sufficient resistance as not to require an additional resistance to be placed in the circuit. The coil  $h$  is also connected by wire  $h^3$  to a rod  $m$ , forming a portion of the support for the lower carbon  $b$ . The support for said carbon  $b$  comprises the rod  $m$ , to the lower end of which is secured a plate  $m'$ , of spring metal, bent into two angular wings. These wings are each centrally apertured, as at  $m^2$ , the diameter of the aperture being larger than the diameter of the carbon  $b$ . When the wings are in their normal position, as indicated in Figs. 1 and 5, the perforations  $m^2$  do not register and the carbon will be bound securely in the perforations to the wings. When, however, the wings are caused to approach a parallel position, the perforations register to a sufficient extent to permit the carbon  $b$  to slide through the wings.

The feed mechanism for the upper carbon  $a$  comprises the solenoid-core  $d$ , from whose base projects a stem  $d'$ , carrying a spring-plate  $d^2$ , having a central aperture  $d^3$ , slightly larger in diameter than the carbon  $a$ . The normal position of this plate  $d^2$  is oblique to the lower face of the core  $d$ , as illustrated in dotted lines in Fig. 1. The free end of the plate  $d^2$  is slotted, as at  $d^4$ , and engages a stop pin or screw  $d^5$ , fixed to the collar  $f^2$ , and forces the plate  $d^2$  to assume a position parallel to the lower face of the core  $d$ . When, now, the core  $d$  rises, the plate will be tilted immediately and will grip the carbon  $a$  and elevate the same. When the core  $d$  falls, the free end of the plate  $d^2$  will impinge upon stop-pin  $d^5$ , and the plate  $d^2$  will be forced into a position substantially parallel with the lower face of core  $d$  and the carbon  $a$  will be released. The upward movement of the core  $d$  in the box  $f$  under the influence of the coil  $h$  is checked or regulated, preferably, in the following manner: From the base of the core  $d$  project the two screw-pins  $p$ , the stems of which traverse loosely the collar  $f^2$ , as indicated in Fig. 3. Between the heads of the pins  $p$  and the collar  $f^2$  and around the stem of said pins are coiled the springs  $p'$ . When, now, the core  $d$  is elevated, the springs  $p'$  will brake or check its movement.

The downward movement of the solenoid-core may be limited or adjusted by the stop pin or screw  $d^5$ , which is adapted to be advanced or retracted in the collar  $f^2$  for this purpose in addition to its other purpose of causing the spring-plate  $d^2$  to assume a position parallel to the base of the coil.

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

1. In an electric-arc lamp, an upper car-

bon, a cap to which the carbon is secured, a contact-brush carried by said cap, a stationary metallic tube connected with one pole of the source of electric energy, said carbon and its cap adapted to slide freely in said tube and said brush adapted to make contact with said tube, and a solenoid-core surrounding said tube and adapted to slide up and down thereon, said core adapted to operate the upper carbon in the tube, substantially as and for the purposes described.

2. In an electric-arc lamp, a feeding mechanism for one of the carbons, comprising a solenoid-core, a stem projecting from the base of said core, a spring-plate fixed at one end to said stem and having a central aperture surrounding the carbon and adapted to normally project obliquely to the base of the core, and a stop-pin adapted when the core is depressed to depress the free end of said spring-plate so that said plate shall assume a position parallel to the base of the core, substantially as and for the purposes described.

3. In an electric-arc lamp, a box or receptacle adapted to inclose the upper carbon and the solenoid-core, said box having its peripheral walls channeled or grooved to form air-flues, substantially as and for the purposes described.

4. In an electric-arc lamp, an upper carbon is adapted to move, a solenoid-core surrounding said tube and adapted to slide up and down thereon, a stem projecting from the base of said core, a spring-plate fixed at one end to said stem and having a central aperture surrounding the carbon, said plate normally projecting from the stem obliquely to the base of the core, a set-screw adapted to form a means for adjusting the downward movement of the core, said screw adapted when the core is depressed to depress the free end of the spring-plate to cause the plate to assume a position parallel to the base of the core, substantially as and for the purposes described.

5. In an electric-arc lamp, a box or receptacle, a solenoid-core adapted to be elevated and depressed in said receptacle, a collar forming a base for the box or receptacle and a support for the core in the depressed position, a headed pin or pins depending from the base of the core and traversing said collar and a spring coiled around said pin and interposed between its head and the collar, substantially as and for the purposes described.

In testimony whereof I have hereunto set my signature in the presence of two subscribing witnesses.

JOHN A. HEANY.

Witnesses:

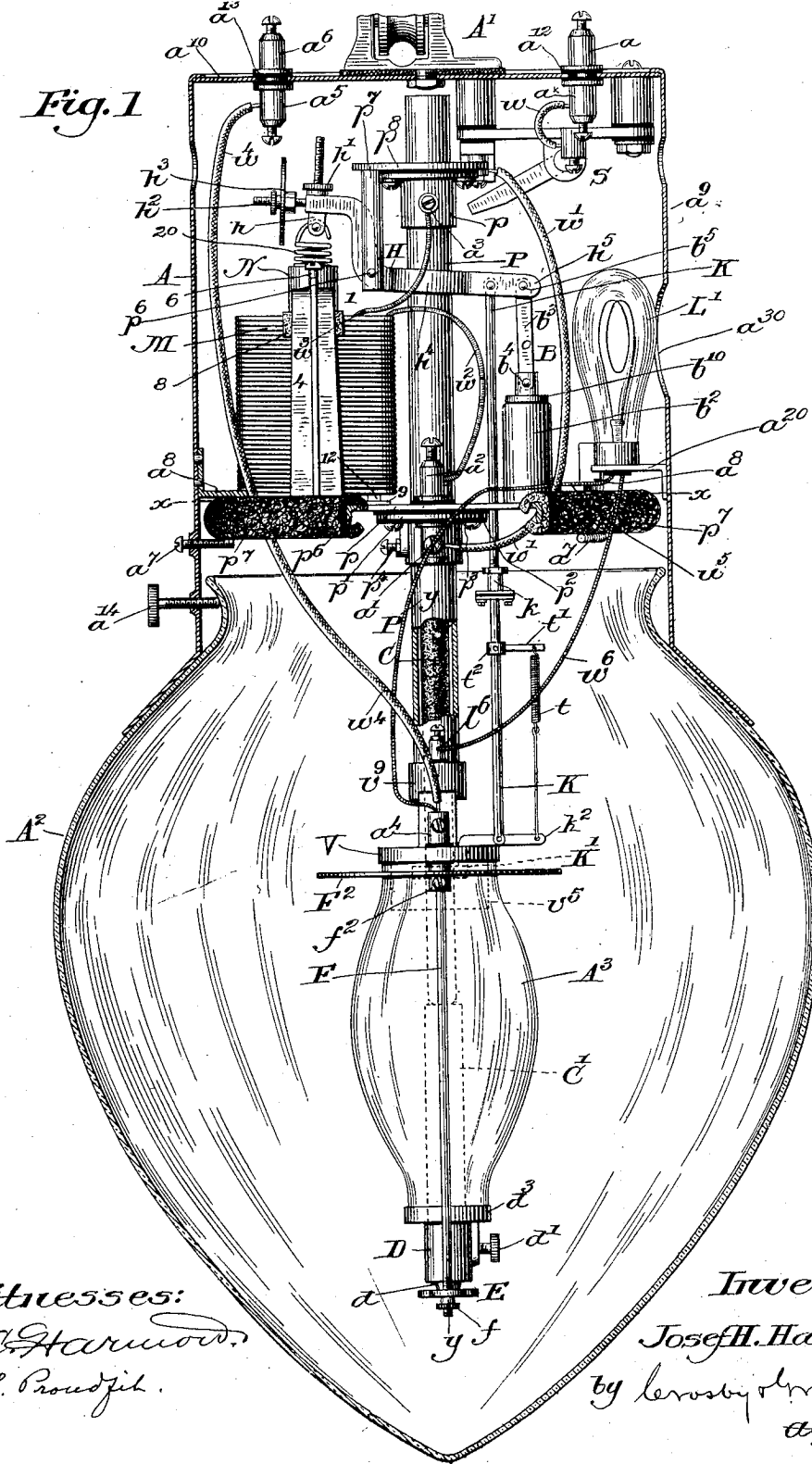
J. WALTER DOUGLASS,  
THOMAS M. SMITH.

J. H. HALLBERG.  
ELECTRIC ARC LAMP.

(Application filed July 16, 1898.)

3 Sheets—Sheet 1.

(No Model.)



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ELECTRIC ARC LAMP.

(Application filed July 16, 1898.)

(No Model.)

3 Sheets—Sheet 2.

Fig. 3.

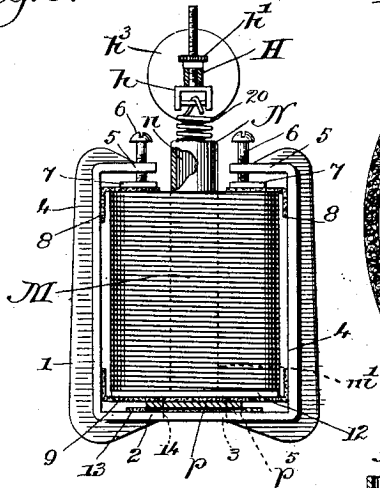


Fig. 2.

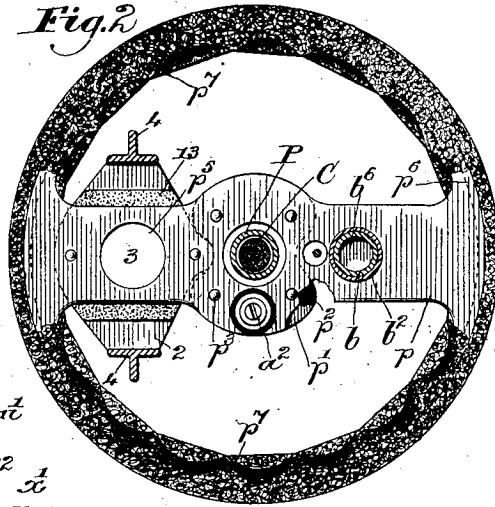


Fig. 5.

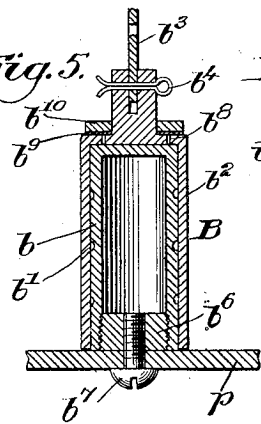


Fig. 6.

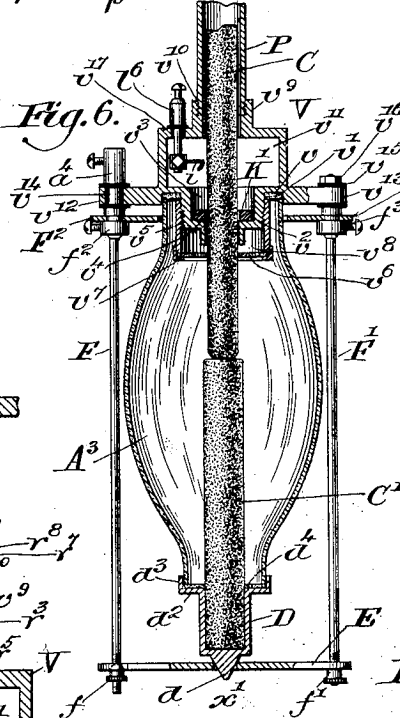


Fig. 4.

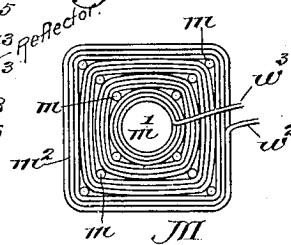


Fig. 7.

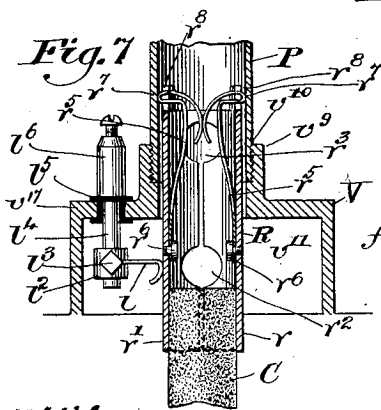
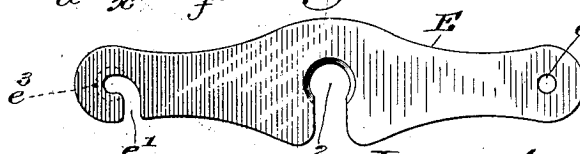


Fig. 9.



Fig. 8.



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ELECTRIC ARC LAMP.

(Application filed July 16, 1898.)

(No Model.)

3 Sheets—Sheet 3.

Fig. 10.

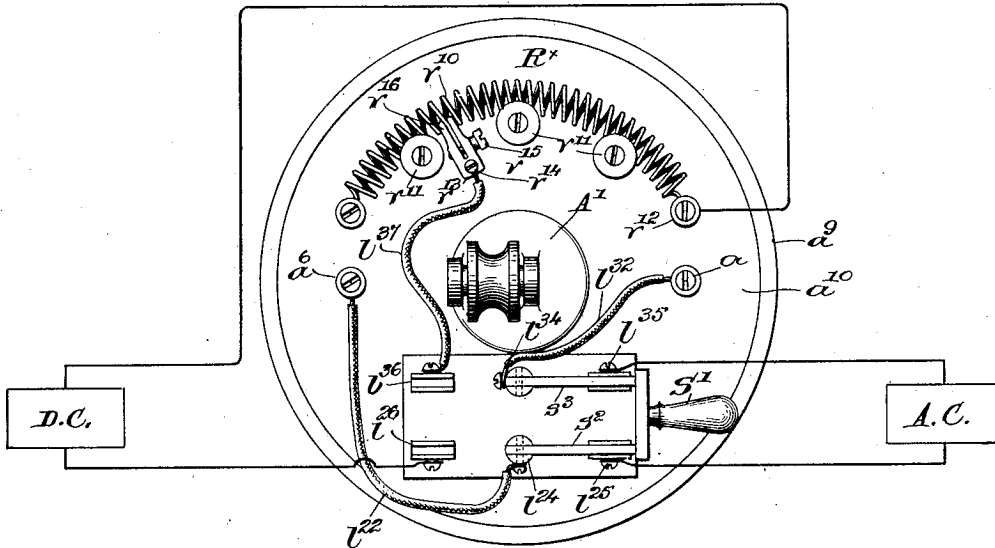


Fig. 12.

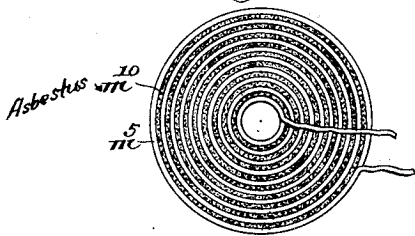
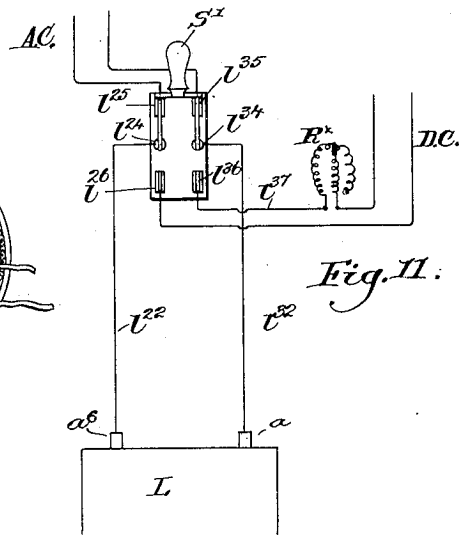


Fig. 11.



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# UNITED STATES PATENT OFFICE.

JOSEF HENRY HALLBERG, OF PEABODY, MASSACHUSETTS, ASSIGNOR TO THE STANDARD THERMOMETER AND ELECTRIC COMPANY, OF SAME PLACE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 663,698, dated December 11, 1900.

Application filed July 16, 1898. Serial No. 686,108. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEF HENRY HALLBERG, a subject of the King of Sweden and Norway, residing at Peabody, in the county of Essex and State of Massachusetts, have invented an Improvement in Electric Lamps, of which the following description, in connection with the accompanying drawings, is a specification, like reference characters on the drawings representing like parts.

This invention has for its primary object the rectification in arc-lamps of certain deficiencies the existence whereof has hindered the utilization upon circuits bearing the alternating current of this type of lamp—a use which for many reasons would grow rapidly in favor were it not for the lack of the improvements hereinafter disclosed.

Such is the nature of these improvements that while chiefly important in their contribution to the production of a successful lamp for alternating currents their embodiment in arc-lamps generically is attended by a remarkable increase in efficiency.

Briefly stated, a more perfect control and regulation of the carbons has been effected by novelty of construction in the governing-magnet and its cooperating parts. Almost perfect noiselessness has been achieved, first, by the improved form of magnet suppressing the chief source of vibration; again, by the provision of vibration-absorbing construction, and, further, by a novel mode of suspension whereby the lamp is isolated from resonators of any description. The initial cost of the lamp and its weight have been cut down by simplicity of design and the use of few parts, and in operating expenses an even more evident reduction has been effected by provision for increased facility in trimming and cleaning, with devices enabling the trimmer to determine visually and at a distance the condition of the carbons, obviating intimate examination of the lamp, which is often situated inconveniently for such inspection. Finally, I provide for the first time a lamp which may be used without alteration or adjustment upon circuits bearing altering or direct currents.

Accordingly my invention is to be considered not as limited to the exact construction

shown, but as broad enough in scope to include the embodiment in any suitable and desired apparatus of the various features which will be hereinafter fully illustrated and described in the drawings and specification, and set forth in the claims.

In the drawings, Figure 1 is a view in front elevation of an "inclosed-arc" lamp in the construction of which various features of my invention have been embodied, the globe and cover of the lamp being shown in vertical section, while parts are broken away in places to reveal more clearly the construction of the central portion of the lamp. Fig. 2 is a horizontal section on the line  $xx$ , Fig. 1, looking from top to bottom. Fig. 3 is a side elevation of the governing magnet or solenoid and the adjacent parts of its support, and Fig. 4 is a plan view of the solenoid. Fig. 5 is a vertical sectional detail of the dash-pot. Fig. 6 is a vertical side elevation of the inner globe and its support, partly in section, looking from right to left on the line  $yy$ , Fig. 1. Fig. 7 is a vertical sectional detail on the line  $x'x'$ , Fig. 6, showing the upper-carbon contact device in its lowered position. Fig. 8 is a plan view of the latch or seat for the bottom carbon and inner globe, and Fig. 9 is a view in side elevation of one of the nuts by which the latch is retained in operative position. Fig. 10 is a plan view of the cover-top with switch and rheostat for use when it is desired to utilize the lamp with both direct and alternating currents. Fig. 11 is a diagrammatic view of a modified arrangement for the same purpose, and Fig. 12 shows a modified form of solenoid to be described later.

Before entering upon a description of the various features of my invention I will indicate first the general operation of the lamp selected for illustration and description as a typical and convenient embodiment of those features.

The electrical current derived from any suitable source (not shown) is led through the double binding-post  $a^x$ , connection  $w$ , switch S, connection  $w'$ , double binding-post  $a' a^2$ , and connection  $w^2$  to the solenoid or magnet M, thence by the connection  $w^3$ , binding-post  $a^3$ , and collar  $p$  to the novel stationary central post P, within which is free to

move the carbon C, the latter deriving current from the post through the rider or contact member R (see Fig. 7) and in turn delivering the current through the arc to the carbon C'. The carbon C' is seated in a receptacle D, which conducts the current to a latch or seat E, supported by hangers F F', through the former of which the current passes to a binding-post  $a^4$ , having a connection  $w^4$  with the double binding-post  $a^3 a^6$ , constituting the other terminal of the lamp. The entrance of the current is accompanied by energization of the solenoid M, which attracts the armature N, and drawing it down thereby through the medium of the feed-lever H, clutch-rod K, and clutch K' raises the carbon C, "striking" the arc, the uniformity of which latter is maintained thereafter by the response of the core N to the magnetic influence of the current acting through the solenoid M. With the knowledge of this mode of operation gathered readily from the foregoing brief description it will be easy to understand the novel technical effect gained by my improvements—an effect which begins to manifest itself at the initial movement of the carbon or upper electrode in striking the arc, since the upper electrode is raised steadily, slowly, and gradually from the lower carbon or electrode, with no suggestion of the chattering or noisy series of jerks which in such lamps prior to my invention has attended or constituted the operation of striking the arc. This novel steadiness and silence so characteristic in the formation of the arc by lamps in which my improved construction is embodied will be found to continue throughout each period during which the lamp is energized and has been attained largely by the novel type of solenoid provided by me for this very purpose. It is recognized generally that to adapt a lamp of this type for use with alternating currents of relatively low frequency a large amount of resistance must be arranged in circuit, and it is recognized equally that it would be desirable to confine this resistance within the limits of a single coil; but a coil of sufficient dimensions has been found impracticable, because subject to the evils attendant upon heating effects of the current.

The use of iron about the coil has increased its tendency to heat and added otherwise to its defects without increasing its efficiency to a compensating degree, so that in practice it has been the custom to introduce an extra resistance-coil into the circuit. With such an arrangement, however, the initial influx of current into the magnet-solenoid exerts too rapidly its influence upon the core, yanks the clutch-lever, and breaks the arc before it is fairly formed, so that with a repetition of these yanks or jerks the carbons chatter violently and annoyingly for a perceptible time before the arc is set.

My improved solenoid is characterized by a separation from each other of its constitu-

ent coils, either the helices or, if desired, the individual convolutions, accomplished in any convenient manner and provided for in the instance illustrated in Figs. 1 and 4 by the introduction of separating devices  $m$ , in the contour, number, and situation of which considerable variation will be found permissible, while in Fig. 12 the separation of the helices and suppression of the bad effects of heating is accomplished even more effectively by the interposition of asbestos or an equivalent heat-suppressing medium  $m^{10}$ . By separating the coils heating effects may be so obviated that the size of the solenoid and its consequent resistance to the initial influx of current may be increased far beyond that found practicable hitherto, and the initial magnetic effect upon the core will be delayed and steadied, as already noted.

Exterior ventilation of the solenoid may be, and preferably is, provided for by isolation from adjacent mechanism so far as practicable, and this I have carried out in the construction of the novel supporting means illustrated, to the exclusive use of which construction I am not bound, however. In the instance illustrated this support is derived from a shelf or member  $p$ , of suitable contour, carried by the central post P in any suitable manner, as by an insulating-collar  $p'$ , provided, preferably, with adjusting means  $p^4$ , the solenoid being in this instance shown as secured to the shelf by a suitable clamp 1, the contour of which may be varied, as desired or found suitable. This is shown as comprising a broad base 2, having a central aperture 3 opposite a similar aperture  $p^5$  in the shelf and the central aperture  $m'$  of the solenoid to promote ventilation, and upright risers 4, with arms, offsets, or holding means 5, provided, preferably, with fastening devices 6, between which and the solenoid may be interposed, if desired, wear-plates or the like 7 and cushioning material 8, preferably of an insulating nature, as asbestos, used also at 9, preferably, and covering as little of the solenoid as possible with efficiency in order to promote ventilation, for which battens may be added also. The layer 9 should have a ventilating-hole, as also the layer 13 when such an additional cushioning layer is used as is desirable.

The armature N may be of any suitable shape and material; but I prefer to make it cylindrical of soft iron with a filling or core of laminated iron  $n$ , as wires, (see Fig. 3,) and I have found it desirable to interpose a spring 20 to take up vibrations between it and the lever H, with suitable adjusting means  $h$   $h'$ , the lever H having also, if desired, regulating or balancing means  $h^2$   $h^3$  of well-known or suitable form. The lever H is carried by the central post P by suitable means, shown in this instance as a pivot  $p^6$  in a bracket-arm  $p^7$  on a bracket  $p^8$ , mounted on and preferably insulated from the collar  $p$ , and adjacent the point of pivotal support, as at  $h^1$ ,

the lever passes around the post P and is extended at  $h^5$  beyond the latter to receive a connection with the upright clutch-rod K and preferably a connection with a suitable dash-pot B. The latter will preferably be of the improved construction I have illustrated in Fig. 5, in which a plunger  $b$  with air-packing grooves  $b^1$ , is supported in upright position to receive a cylindrical shell  $b^2$ , hung by an adjustable link  $b^3$ , with fastening means  $b^4$   $b^5$  from the lever H. The plunger  $b$  is preferably secured, as by a base  $b^6$  and screw  $b^7$ , to the shelf  $p$ , and the shell  $b^2$  has vents  $b^8$  operative normally upon descent of the shell to allow the carbon C to fall quickly, but closed by a paper washer  $b^9$ , operated by suction, aided, preferably, by a weight  $b^{10}$  to close the holes and retard upward movement of the carbon C.

The clutch-rod K has preferably an insulating and adjusting joint  $k$  and a clutch  $K'$ , both of well-known or suitable form, and I provide, preferably, a vibration-absorbing device to take up any vibrations inseparable from the use of the alternating current and escaping the various vibration-deadening devices, to which reference has been made already. This comprises a spring  $t$ , interposed between the clutch-arm  $k^2$ , extended beyond the rod K for the purpose, and a support  $t'$ , carried adjustably by the clutch-rod K. In practice I find that this device prevents effectually any joggling down of the carbon in the clutch, so often resulting in burning out the solenoid when older types of these lamps are used in places subject to mechanical jar—as, for example, on the posts to which the trolley-wire of electric railways is attached. As the carbons are consumed the arc lengthens, its resistance increases, and the amperage in the solenoid decreases, releasing the armature, which rises under the drag set up by the weight of the clutch, its rod, and the carbon, and the latter is permitted to descend, approaching the lower carbon until, through the decreased length and resistance of the arc, an amperage is obtained in the solenoid sufficient to again exert a restraining tendency on the armature N, checking the carbon. Here again the effect of my improvements in the solenoid is manifest, inasmuch as the relatively large coil once saturated with the current presents a greater sensitiveness to variations of current strength than does a smaller coil, either when the latter is alone or when hampered by the influence of an extra coil. Not only does this sensitiveness make for greater steadiness of the arc, but it enables me to maintain an arc within two or three volts of the point at which the arc breaks under normal conditions, instead of setting the mechanism to act at several volts under that point. Those skilled in the art will understand readily that thereby I secure a longer arc, brighter and more extended illumination, and less shadow than can be attained with

the lower voltage, which prior makers have not dared to exceed, through fear of inability on the part of their solenoids to respond promptly to a sudden accession of amperage following the passing of an irregularity in the carbons, which has temporarily raised the voltage and caused the arc to shorten. Frequently this slowness to respond permits overload and burning out of the solenoid, with other damage to the lamp, and at least an annoying flickering of the light attends the advent of each impurity as the carbons are consumed.

Not only does the elimination of the extra resistance-coil effect an obvious reduction in expense, but an advantage far from least among those attained is the suppression of a noise-producing factor, since each coil adds its quota to the vibration set up in the lamp by the current, especially an alternating current.

I have already referred to the use of layers 8 and 9 of asbestos or similar sound-deadening material between the magnet-coil M and its support, and I now call attention to the fact that the coil is more or less flexibly supported by the clamp-risers 4 and pass on to one of the features of my invention by which the very important requisite of noiselessness is chiefly furthered.

Heretofore it has been the custom, so far as I am aware universal, to suspend arc-lamps directly by some rigid portion of their structure and to attach the cover thereto without regard to its quality as a resonator, so that through the rigid structure of the lamp each vibration was transmitted to the lamp-cover and to the ceiling, &c., and thence in exaggerated degree to the air of the room. I have made a complete reversal of this practice, furnishing the cover with the means for suspension from ceiling or the like and supporting the structure of the lamp proper from the cover, interposing, however, between the two sound-deadening means, so that such vibrations as may escape to the lamp skeleton from the solenoid through the layers 8 and 9 or their equivalent will be taken up before they can reach the resonating-surfaces of the cover and ceiling. This I believe to be new, broadly, and hence do not restrict myself to the particular construction illustrated, wherein the shelf  $p$  presents an extension or member  $p^6$ , shown as annular, covered with a spring or springy jacket  $p^7$ , of felt or the like, to rest upon suitable projections  $a^7$ , preferably screws, extended inwardly from the cover A, other projections, as the brackets  $a^8$ , being provided, preferably, to steady the ring and limit its entrance within the cover.

A hanger  $A'$ , of any well-known or suitable form, may be provided, if desired, at the top  $a^{10}$ , and if the latter is of metal insulating-bushings  $a^{12}$   $a^{13}$  should be provided for the binding-posts  $a$   $a^6$ , respectively.

The form of cover A and globe  $A^2$  may be varied, as desired and found suitable, and any suitable means of supporting the latter may

be adopted, thumb-screws  $a^{14}$  constituting one convenient form of such means.

Passing now to the carbon supporting or "trimming" mechanism, (best seen in Figs. 1 and 6,) abundant novelty will be found in the few light parts of its compact construction, comprising as essentials only a head V, hangers F F', a swinging seat or latch E, and receptacle D. Any suitable means to connect the latch or seat E with the hangers F F' may be utilized, and as one form the nuts  $f f'$ , engaging threads on the lower ends of the hangers, have been found convenient, especially when the seat takes the form of the latch illustrated and best seen in Fig. 8, having an aperture  $e$  at one end to permit the passage of one hanger, about which the latch can be rotated without the necessity for entire removal, a slot  $e'$ , preferably curved, serving at the other end of the latch to permit the entrance laterally of the other hanger as the latch swings around into closed position, a similar medial slot  $e^2$  being provided, preferably, to receive the foot of the receptacle D of suitable contour to cooperate with the enlarged and countersunk inner end of said slot. To trim the lamp, the nuts  $f f'$  are lowered and the latch swung around from under the receptacle D, when the latter will come out in the hand, bringing with it the lower carbon C', to hold which firmly in the receptacle fastening means  $d'$  are provided, preferably, while the inner globe A<sup>3</sup> merely rests snugly, but freely, at its lower end on a shoulder  $d^2$  of the receptacle, which may, and preferably does, have a seat washer or gasket  $d^4$  and a retaining-flange  $d^3$ . At its upper end the inner globe is seated in a similar manner against the head V, which preferably has an annular depression or seat  $v$  and gasket or washer  $v'$  also. Coaxial with this depression and within the same extends downwardly a boss  $v^2$ , having a central aperture to permit passage of the carbon or upper electrode C, this aperture being enlarged to receive the clutch K', which is seated at times against the shoulder  $v^4$ . A ring or ferrule  $v^5$  serves the double function of holding the washer  $v'$  in place and supporting an annular disk or gas-check  $v^6$ , preferably of lava or other heat-resisting and insulating material, suitably secured to the ring, as by an apertured screw cap or rim  $v^7$ , and forming, with the ring  $v^5$  and shoulder  $v^4$ , a gas-chamber  $v^8$ . Above the head a crown  $v^9$  connects with the post P in suitable manner, as by a thread  $v^{10}$ , to derive support therefrom and is apertured, as at  $v^{11}$ , to give access to the upper carbon C, while in the arms  $v^{12} v^{13}$  are held the upper ends of the hangers F F', insulated by bushings  $v^{14} v^{15}$ , a suitable annular reflector F<sup>2</sup> being mounted, preferably, above the arc and supported in suitable manner, as by screw-collars  $f^2 f^3$ , on the hangers F F'. In trimming, the latch having been swung away and the receptacle D, with carbon C', having

been removed, the inner globe will come away freely in the hand of the operator, ready for washing in hydrofluoric acid if need be, since it is without attached metal parts, so that no time will be lost in cleaning it. The upper carbon will then fall down until the rider R (see Fig. 7) rests against the clutch K', (see Fig. 6,) through which the rider cannot pass, normally preventing the upper carbon from falling out. Then the operator will pull the carbon out, grasp the rider through the head-aperture  $v''$ , and insert a new carbon, and after the new carbon has been pushed up within the post P the inner globe A<sup>3</sup>, lower carbon C', and receptacle D may all be replaced at once, the latch E swung around, the nuts  $f f'$  tightened up, and the operation of trimming will have been accomplished.

The small size of the hangers F F', insulated from the head at  $v^{14} v^{15}$ , and of the receptacle D and seat or latch E is worthy of remark, as entirely unprecedented, but no lack of security has been experienced in their use largely on account of the novel and rigid central post P.

To aid in retaining the latch in closed position, I prefer to make use of a countersink in the latch, (shown in dotted lines at  $e^3$ , Fig. 8,) into which countersink enters the beveled end  $f^3$  of the nut  $f$ . (See Fig. 9.)

Reverting to the "rider" or sliding contact R, (see Fig. 7,) this may be varied in form without departing from the spirit of my invention; but I have illustrated one form which has shown itself capable of extended use, its simplicity of structure leaving little opening for breakdowns or failure to operate properly. The form of rider illustrated comprises a cylindrical tube of resilient material fitting loosely within the post P and split throughout a considerable portion of its length to form jaws  $r r'$ , which engage and grasp the head of the carbon C with sufficient force to prevent displacement by shock or otherwise accidentally. This split may be on one or both sides, and preferably is enlarged at one or more points, as at  $r^2 r^3$ , to augment resiliency of the jaws, the lower aperture serving the additional function of means to give the operator a better grip either with his fingers or with a pencil or the like if the carbon and rider be heated.

To insure contact with the walls of the post P, some form of current-collecting device  $r^5$  is used, preferably, and I have shown as one form a spring or springs secured by suitable fastening means  $r^6$  to the body of the rider and extended beyond the walls thereof to contact yieldingly with the walls of the post P, the two springs in the instance illustrated being bent back upon themselves at  $r^7$  in position to contact with each other, thus deriving mutual support with enhanced resiliency and conductivity. As one means to protect these devices from injury, the walls of the rider may be extended above the devices and

slotted or otherwise apertured, as at  $r^8$ , to permit access of the devices to the walls of the post.

An important feature of my invention is the provision of means to indicate visually to the operator standing at a distance the condition of the carbon, and as I believe myself to be the first to provide such means I do not limit myself to the exact form shown, which consists simply of a small incandescent lamp L, situated at any convenient portion of the arc-lamp, as on a support  $a^{20}$ , adjacent an aperture  $a^{30}$  in the cover, through which the light of the lamp when energized will be visible. A conductor  $w^5$  taps the circuit at a convenient point, as at the binding-post  $a^4$ , and another conductor  $w^6$  leads to a point adjacent the carbon, where is arranged a circuit-closer comprising a stationary, but preferably adjustable, member adapted to be engaged by a cooperating member movable with and controlled by the carbon, the latter member consisting most conveniently of the rider R itself, as indicated in Fig. 7. In this instance the other member  $l$  of the circuit-closer is carried by the crown-shoulder  $v^{17}$  through the medium of a projection  $l^4$ , insulated at  $l^5$  from the shoulder and having an adjustable collar  $l^2$ , which presents a member  $l$  toward and in position to be engaged by the rider R. Upon such engagement a circuit in shunt with the arc is completed through the member  $l$ , projection  $l^4$ , binding-post  $l^6$ , conductor  $w^6$ , (see Fig. 1,) lamp L, and conductor  $w^5$ , back into the circuit of the arc-lamp itself. This indicating means may be set by adjustment of the collar  $l^2$  in this instance to operate when the carbons have yet to burn, say, fifteen hours, and if the lamps are installed by the hundred in some stores the trimmer need only walk across the front of the store and glance back at the lamps to determine by the glow of the incandescent lamps which of the arc-lamps are in need of attention. By this provision not only the time of the trimmer, so often wasted in useless climbing of ladders to inspect the lamps, is saved, but the annoyance of his presence in the confined space of the store or the like place is obviated, to the great relief of the user.

I have called attention already to the capability possessed by arc-lamps embodying my improvements for use on circuits bearing alternating currents or direct currents without change, alteration, or adjustment of the lamp, and I have shown, diagrammatically, in Fig. 12 connections convenient for use in a situation where access is had to circuits bearing, respectively, the types of current mentioned, that lettered A C supplying the alternating current and that lettered D C the direct current.

L designates the lamp, from the terminals  $a^6$   $a$  of which run conductors  $l^{22}$   $l^{23}$ , respectively, to the middle terminals  $l^{24}$   $l^{21}$  of a cir-

cuit-controller, indicated as a six-pole double-knife switch, having opposite pairs  $l^{25}$   $l^{35}$  and  $l^{26}$   $l^{36}$  of terminals receiving, respectively, the alternating-current and the direct-current leads, the latter having the usual rheostat  $R^x$  included in its circuit. When the handle S' of the switch is in its upper position, as indicated, the alternating current may pass in at the terminal  $l^{25}$ , thence through the left-hand switch-lever to the middle pole  $l^{24}$  and along the conductor  $l^{22}$  to the lamp, returning through the lamp-terminal  $a$ , conductor  $l^{23}$ , poles  $l^{34}$   $l^{33}$ , and intermediate switch-lever to the other alternating-current lead. A simple throw of the switch-handle S' brings the switch-levers down to the terminals  $l^{26}$   $l^{36}$ , cutting in the direct current in a manner precisely similar to that just detailed.

In Fig. 11 I have shown a plan view of the cover-top illustrated in Fig. 1, with the controlling-switch and rheostat mounted in combination thereon, the parts indicated, diagrammatically, in Fig. 12 being shown in detail, but no difference existing in the operation, which I will not repeat, referring only to the construction of the rheostat illustrated, a form convenient, but not essential. To the terminal  $l^{26}$  of the switch a flexible, preferably insulated, conductor  $l^{27}$  is attached at one end, the other end of the conductor being free to move adjacent the coils of a resistance-helix  $r^{10}$ , preferably composed of bare wire supported above and insulated from the cover-top  $a^{10}$  by suitable means, as the well-known screw-knob insulators  $r^{11}$  illustrated. At  $r^{12}$  a binding-post or other suitable means is provided to permit connection of a direct-current lead to the resistance, and I have shown the flexible connection  $l^{27}$  as provided with means to effect detachably a union with the resistance at any desired point, one convenient form of such means comprising a clamp  $r^{13}$ , secured by a set-screw  $r^{14}$  and having preferably another set-screw  $r^{15}$  to enable its jaws  $r^{16}$  to be attached firmly to the coil selected. As a single instance of the type of situation in which this combination may be employed to advantage, I may mention a shop having a direct-current circuit energized by its own dynamo during the daytime, but dead at night, while the alternating current of a nearby street-circuit is available at night, there being frequent occasion for illumination in parts of the shop after the power has shut down or perhaps broken down.

Obviously enough to be able by the simple turn of a switch to utilize the street-current in a lamp already at hand is more than desirable, and this capability exists in arc-lamps for the first time, so far as I am aware, by virtue of my improvements.

Having described my invention thus fully, I do not limit myself to the exact construction shown and described, since the same may be varied in many respects without departing from the spirit of my invention; but

That which I claim, and upon which I desire to secure protection, is—

1. The combination with a lamp of the class described, its cover-top and terminals, of a six-pole double-knife switch mounted on said top and having its middle pair of poles connected respectively with said lamp-terminals, its pair of poles at one end adapted to receive the leads of a circuit bearing the alternating current, and its other pair of end poles adapted to receive, one pole a lead of a circuit bearing the direct current, and the other pole a flexible conductor provided near its free end with a clamp, and adapted to serve as the movable member of a rheostat which includes a coil of bare resistance-wire, mounted on knob-insulators extended above said cover-top, and presenting its convolutions in position to be grasped by said conductor-clamp, at different points.

2. A vibration-absorbing support for the magnets of electric-arc lamps, comprising a shelf upon which said magnet is seated; and a clamp having a broad base traversing said shelf on the side opposite said magnet, said clamp being provided with risers extended from said base along said magnet lengthwise and with retaining-arms to hold the other end of said magnet.

3. A vibration-absorbing support for the magnets of electric-arc lamps, comprising a shelf upon which said magnet is seated; and a clamp having a broad base traversing said shelf on the side opposite said magnet, said clamp being provided with risers extended from said base along said magnet lengthwise and with retaining-arms to hold the other end of said magnet, and fastening means intermediate said arms and clamp.

4. A vibration-absorbing support for the magnets of electric-arc lamps, comprising a shelf upon which said magnet is seated; and a clamp having a broad base traversing said shelf on the side opposite said magnet, said clamp being provided with risers extended from said base along said magnet lengthwise and with retaining-arms to hold the other end of said magnet, said shelf and base being apertured opposite the central bore of said magnet to promote ventilation.

5. An electric-arc lamp having a cylindrical cover and means to suspend the same; a frame comprising a central post having a shelf provided with an annular member; means intermediate said cover and member to enable said cover to sustain said frame; and a springy or cushioned medium intermediate said member and sustaining means.

6. A rider or contact member for the carbons of arc-lamps comprising a cylindrical tube adapted to be seated upon the upper end of said carbon, and provided with current-collecting devices, and means tending normally to press said devices outwardly from the walls of said rider.

7. A rider or contact member of the class described having current-collecting devices comprising springs secured to the inner walls of said cylinder and tending normally to present current-collecting surfaces beyond the outer walls of said tube.

8. A rider or contact member of the class described having current-collecting devices comprising springs secured to the inner walls of said cylinder and tending normally to present current-collecting surfaces beyond the outer walls of said tube, said springs being bent back upon themselves from said collecting-surfaces, opposite and in contact with each other and serving mutually each to augment the resiliency of the other and cooperating to conduct the current to the rider.

9. The combination with the clutch-rod of an arc-lamp and a clutch of the pivoted ring type, of a tension-spring interposed between an arm extended from the clutch-ring beyond its pivot, and a point of support on the clutch-rod, said spring being adapted to take up vibrations of the lamp-frame and prevent their transmission to said clutch and carbon.

10. The combination with the clutch-rod of an arc-lamp and a clutch of the pivoted ring type, of a tension-spring interposed between an arm extended from the clutch-ring beyond its pivot and a point of support on the clutch-rod, said spring being adapted to take up vibrations of the lamp-frame and prevent their transmission to said clutch and carbon; said support being adjustable on said rod to permit said adjustment of said spring.

11. The combination with the carbon-controlling mechanism, of an arc-lamp, of a dash-pot comprising a stationary plunger provided with air-packing grooves; a cylindrical shell fitting snugly on said plunger, and having vents in its closed end; and a washer and cooperating weight adapted to permit ready assembly of said shell and plunger telescopically and consequent approach of the carbons, but to close said vents and impede separation of shell and plunger, and consequently of the carbons.

12. In an arc-lamp, a head or member of the class described; having a central aperture to permit passage of the upper carbon, a crown portion with an upper attaching-aperture and transverse trimming-passage, said head being adapted to receive hangers or supporting means for the lower carbon.

13. A head or member of the class described provided with a downwardly-extended boss arranged coaxially with respect to the central carbon-aperture; combined with a ring, larger in diameter than said boss, and presenting toward the arc an annular disk of lava or other suitable insulating and refractory material, and adapted to form, with said ring and boss, a gas-chamber, surrounding the upper carbon.

14. The combination with an arc-lamp hav-



ing a head V and a cover provided with a  
view-opening, of an incandescent lamp situ-  
ated adjacent and visible through said view-  
opening, an adjustable contact member ad-  
5 jacent the path of the upper carbon in said  
head, and connections between said adjust-  
able contact member, said incandescent lamp  
and the leads of said arc-lamp to enable said  
incandescent lamp to be energized upon the

attainment by said carbon of a predetermined po-  
sition, substantially as described.

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

JOSEF HENRY HALLBERG.

Witnesses:

ALEXANDER C. PROUDFIT,  
JOHN C. EDWARDS.

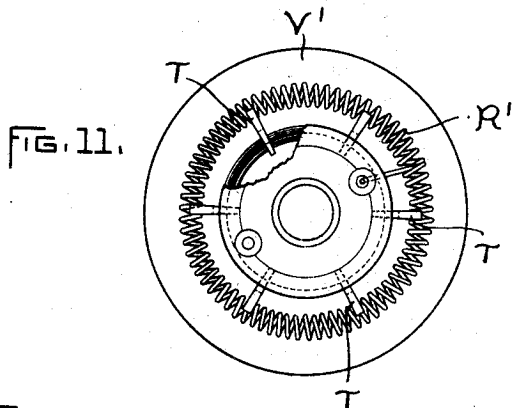
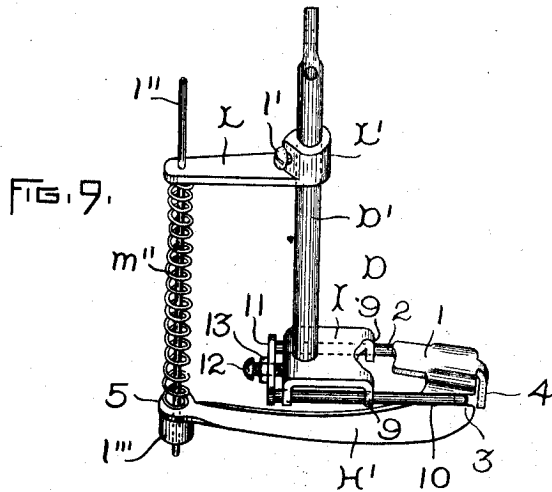
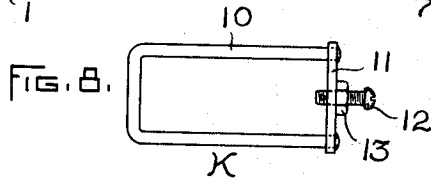
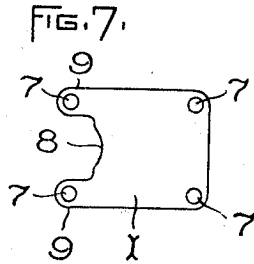
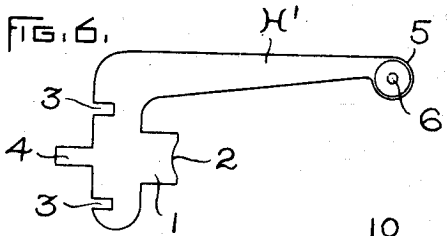


E. THOMSON & C. E. HARTMAN.  
ELECTRIC ARC LAMP.

(No Model.)

(Application filed Oct. 19, 1897.)

2 Sheets—Sheet 2.



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*att'y.*

# UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, AND CHARLES E. HARTHAN, OF LYNN, MASSACHUSETTS, ASSIGNORS TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 667,106, dated January 29, 1901.

Application filed October 19, 1897. Serial No. 655,705. (No model.)

*To all whom it may concern:*

Be it known that we, ELIHU THOMSON, residing at Swampscott, and CHARLES E. HARTHAN, residing at Lynn, in the county of Essex, State of Massachusetts, citizens of the United States, have invented certain new and useful Improvements in Electric-Arc Lamps, (Case No. 638,) of which the following is a specification.

10 This invention relates to electric-arc lamps, and has special reference to the clutch mechanism for feeding the upper carbon.

15 The invention also has reference to details of construction of other parts of an electric-arc lamp, as herein set forth and claimed.

The lamp herein set forth presents certain features making it available for use with alternating currents.

20 Referring to the accompanying drawings, Figure 1 is an elevation in vertical section of an electric-arc lamp embracing the invention. Figs. 2, 3, 4, and 5 are details of the magnetic core, by means of which the lamp is regulated. Figs. 6, 7, 8, and 9 are details of the clutch mechanism. Figs. 10 and 11 are details of the lamp.

25 In the construction of the lamp A is a suitable casing inclosing the carbon feeding and regulating mechanism. The globe B is suspended therefrom by means of rods *a a*, telescoping or extending through tubes *b b*, suspended from the casing A, the rods *a a* being held in their elevated position by means of hooks *c* at their upper ends engaging with latches *d*, mounted on casing A and operated by a button *e*. The lower ends of the tubes *b* are connected by a cross-bar *f*, having a socket *f'*, in which rests the lower carbon *g*.

30 The lower ends of the rods *a* are connected by a cross-bar *h*, having a central depending screw-threaded projection *i*, extending through a circular support *k*, on which rests the globe B. The globe B is tightened into position by a thumb-nut *j* on the threaded projection *i* and bearing up against the under side of the support *k*. The latter and the globe B are kept from being turned by the thumb-nut *j* by a cross-piece *l*, mounted on the support *k* and extending under the latter through a slot *j'* in the depending portion *i'* of the threaded projection *i*. An inverted

plan view of this construction is shown in Fig. 10. The release of the globe and its entire removal with its support *k* may be effected by unscrewing the thumb-nut *j* until it is free of the threaded portion *i*. The globe when in its normal raised position is locked by reason of the shape of the hooks *c* and latches *d*, and in order to lower the globe it is necessary to first move the holder upward slightly by hand, which raises the hooks to a point where the latches *d* may be removed by rotating the button *e* on the outside of the lamp.

35 The lamp is provided with an outer casing *m*, consisting of a thin shell of metal extending upward from the top of the globe. Just above the globe B the casing *m* is provided with a hollow ring *n*, forming an air-space and open at the top, above which is located a hood *o*. The shell *m* is provided with openings *p* just below the bottom casing *q*, which form exits for the heated air from the globe into the air-space in ring *n*, the air escaping from the latter beneath hood *o* into the open air. It will be seen that by the screwing up of thumb-nut *j* the globe B will be pressed up against the lower portion of casing *m* and ring *n*.

40 Through the casing A projects the rod C for holding the upper carbon *g'*, secured by a suitable clamp *C'* to the lower end of rod C. The upper portion of rod C projects into a tubular chamber *C<sup>2</sup>*, located on the top of casing A. Within the casing A a suitable clutch D is located, which operates to grasp and raise the rod C. The clutch D is raised by means of a vertical rod *D'*, connected at one end to clutch D and at the other to a lever E, pivoted to lugs (indicated by dotted lines at *E'*, Fig. 1) depending from the lamp-frame, and the rod *D'* is in turn raised by lever E, hinged to a magnetic core F, suspended in the magnet-coil G, the core F acting upon lever E. The coil G, which is traversed by the current which maintains the arc, is mounted on a spring *G'* or other yielding support. This is especially important when the current is alternating. The spring *G'* has a tendency to prevent the vibrations of the coil G, due to the alternating current, from reaching the framework of the lamp

and causing humming. The spring G' surrounds a rod or other suitable support G<sup>2</sup>, which acts as a guide to direct the movements of the coil, and thereby maintain it in parallel relation with the core F. A dash-pot H, connected to the outer end of lever E, serves to regulate the motions of the carbon-feeding mechanism. As shown, the cylinder of dash-pot H is movable and its piston is fixed.

The clutch employed herein is preferably constructed as follows: It is formed of several parts stamped out of sheet metal. In Fig. 6 is shown the blank for the movable jaw of clutch D, made of sheet metal, which may be phosphor-bronze, and which is so notched and shaped, as shown in Fig. 6, that it may be bent into complete form. (Shown in Fig. 9.) In its complete form the movable jaw comprises a thin vertical portion forming the arm H', a flat horizontal portion 1, forming a jaw having a curved edge 2 to fit the side of the carbon, two notches 3 3, and a depending portion 4 at the outer end of the portion 1. The other end of arm H' is formed with a horizontal flattened portion 5, having a perforation 6. In Fig. 7 is a blank I, which is shaped and bent to form the other jaw of the clutch, as shown in Fig. 9. The blank I is of a square shape and is provided with perforations 7 at its corners and with a curved edge 8 in a cut-away portion at one side to fit against the side of the carbon-rod, the cut-away portion forming the projections 9. The latter are bent downward at a right angle, and the opposite end of blank I is similarly bent, as shown in Fig. 9, thereby bringing the perforations 7 in alignment, as shown.

In Fig. 8 is shown a frame formed of an oblong U-shaped wire part 10 and cross-piece 11, secured to its ends. The cross-piece 11 is provided with a small screw 12 and jam-nut 13, as shown in Fig. 9. The jaw formed from the blank I is mounted on the frame K, the wire part 10 extending through perforations 7 and through notches 3 3 in the other part of the jaw. The jaw formed from the blank I is mounted also on the lower end of the rod D'. By means of set-screw 12 and jam-nut 13, which bears, as shown, against the rear of the jaw formed from blank I, the latter can be adjusted on the wire part 10 to the proper position for cooperating with the other jaw to clutch the carbon-rod and also to compensate for wear of the clutch, thereby prolonging the life of the latter.

To hold the jaw *l* in closed position, release it from the carbon-rod, and restore it to closed position, the following device is employed: Upon the rod D' is mounted a bracket-arm L, having a sleeve L' and set-screw *l'*, engaging the rod D', whereby the arm L can be adjusted upon the rod D'. A rod *l''* extends through the outer end of arm L and through the perforation 6 in the end of arm H' and a stop or enlargement *l'''* beneath the end of H', the lower end of *l''* depending from stop *l'''*.

Mounted on the rod *l''* and located between the outer end of bracket-arm L and the outer end of arm H' is a coiled spring *m''*, the tension of which may be regulated by adjusting the arm L on rod D'. The jaw *l* is held in its normal closed position by the spring *m''* holding down the outer end of arm H'. When the clutch is lowered by the action of the feeding mechanism, the stop *l'''* is brought against the bottom of casing 1, or a suitable abutment thereon, which raises the outer end of arm H' and releases jaw *l*. In the upward movement of rod C the spring *m''* reacts to close the jaw *l* and cause it to grasp the upper carbon-rod. The lower end of rod *l''* projects through a hole *n'* in the bottom of casing A and is provided with a button *n''*, by which the jaw *l* may be released by hand, if desired. When alternating currents traverse the coil G, it is desirable to laminate the iron core F thoroughly. For this purpose the core F is preferably constructed as follows: As shown, three thin strips of iron M are riveted together, having the same length as the core and so bent as to afford wings M', one hundred and twenty degrees apart, and a central tubular passage-way M'' for a wire N, extending through the same. The extremities of the wings M' are bent inward to form the core F in the shape of a cylinder, as shown in Fig. 4 and in dotted lines in Fig. 2. The hollow spaces thus formed are packed with iron wires, as indicated at N' in Fig. 4. The slots which exist between the edges of the wings M' are covered with mica or other material, which prevents the escape of the wires. The wire N, extending through the core G, is provided with a disk *p* at its upper end and disks *p''* at its lower end, a spring P being located between the upper end of core F and disk *p* and a spring P' being located between the disks *p'' p''*. These springs tend to allow the core a certain play under the alternating magnetism, which play or tremor is not conveyed in its full force to the moving parts of the feed mechanism, such as lever E and clutch D.

The core G, constructed as set forth, affords a solid structure laminated and so arranged as to prevent inductual currents, and thereby avoid heating.

R indicates the resistance, located in the top of the lamp and preferably constructed as follows:

The resistance R is composed of spirals R', of German silver or other high-resistance wire, wound upon a suitable support S, of refractory material of an insulating character. The support S is constructed of a number of pieces T, of baked earthenware or dorelain, having projections T' at their ends which fit into grooves or depressions U in the plates V V', the plate V being at the top of the lamp-case and the plate V' resting on the top of the casing A. The pieces T have notches *t* in their outer part in which lie the wound spirals R'. (Shown in plan view in Fig. 11.)

The circuit of the lamp is indicated by dotted lines and is from terminal  $V^2$  to and through the resistance-wire  $R'$ , from thence to and through coil  $G$ , from coil  $G$  by suitable contacts to and through the carbon-rod  $C$ , through carbons  $g g'$  to the lower framework, and back by suitable connections, such as an insulated cable, as usually provided, to the outgoing terminal  $V^3$  of the lamp.

10 What we claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a carbon feeding and regulating mechanism for electric-arc lamps, the combination of a magnet-coil, a coiled spring situated below the coil, upon which it is yieldingly supported, a core mounted for movement, a feed mechanism, and a spring connection between the core and the feed mechanism, the arrangement being such that both the core and the coil are movable for the purpose of reducing vibration and humming.

2. In an electric-arc lamp, the combination of a clutch, an actuating-coil, a coiled spring situated below the coil for supporting it, and also permitting it to move slightly in a vertical direction, a guide for directing the vertical movement of the coil, a core movable within the coil, a connection between the core and the clutch, and springs situated above and below the core, which form an elastic connection between the core and the clutch.

3. In an electric-arc lamp, the combination of a magnet having a central opening for receiving the core, a coiled spring situated below the magnet and tending at all times to move the magnet upward, a guide for directing the movements of the magnet, a spring-supported core arranged to move within the magnet and to control the feed of the lamp, and means for maintaining the core and magnet in parallel relation.

4. In a carbon feeding and regulating mechanism for electric-arc lamps, a spring-supported magnet-coil, a guide therefor in combination with a core movable endwise on its support and provided at its ends with controlling-springs, as and for the purpose set forth.

5. A carbon feeding and regulating mechanism for electric-arc lamps, comprising a vertically-movable carbon-carrying rod, a horizontal lever pivoted to a fixed part of the lamp, a magnet-core suspended from one end of said horizontal lever and movable endwise on its support, springs controlling the endwise movement of the core, a magnet-coil mounted on a yielding support, a clutch engaging the carbon-rod, and a vertical rod suspended from the other end of said horizontal lever and connected to one of the jaws of the clutch, whereby upon the descent of said vertical rod the clutch releases the carbon-carrying rod, as set forth.

6. A carbon feeding and regulating mechanism for electric-arc lamps, comprising a vertically-movable carbon-carrying rod, a horizontal

lever pivoted to a fixed part of the lamp, a magnet-core yieldingly supported on one end of said horizontal lever, a magnet-coil mounted on a yielding support, a clutch normally engaging the carbon-rod, a vertical rod suspended from the other end of said horizontal lever and connected to one of the jaws of the clutch, a spring holding the other jaw in engagement with the carbon-rod and serving to restore it to engagement with the latter when released, and means for releasing the clutch from the carbon-rod, substantially as set forth.

7. A carbon feeding and regulating mechanism for electric-arc lamps, comprising a vertically-movable carbon-carrying rod, a horizontal lever pivoted to a fixed part of the lamp, a magnet-core yieldingly suspended from one end of said horizontal lever, a magnet-coil mounted on a yielding support, a dash-pot suspended from the other end of said lever, a clutch normally engaging the carbon-rod, a vertical rod also suspended from said other end of the horizontal lever and connected to one of the jaws of the clutch, a spring for holding the other jaw of the clutch in engagement with the carbon-rod and serving to restore it to engagement therewith when released, and means for releasing the clutch from the carbon-rod, substantially as set forth.

8. A magnet-core, consisting of a solid body having its exterior formed of thin sheet metal, and its interior with lengthwise partitions of thin sheet metal, and wires filling the compartments formed by the partitions, substantially as set forth.

9. A magnet-core, consisting of a laminated structure of thin sheet metal with a central opening and partitions lengthwise, and wires filling the compartments formed by the partitions.

10. A magnet-core consisting of thin sheets of metal extending lengthwise of the core and bent to form a central passage-way, lengthwise partitions and the exterior wall of the core, and wires filling the compartments formed by the partitions.

11. A magnet-core consisting of strips of thin metal bent to form a central opening for the passage of a wire or rod, lapping lengthwise wings forming partitions, diverging outer portions forming the exterior of the core, and wires filling the compartments formed by the partitions.

12. In an electric-arc lamp, a vertically-movable carbon-carrying rod, a lever pivoted to a fixed part of the lamp, an electromagnet having a core suspended from one end of the lever, a clutch normally in engagement with the carbon-carrying rod and having a fixed jaw, a vertical rod suspended from the other end of the lever and connected to the fixed jaw, a movable jaw, a spring holding the movable jaw in engagement with the carbon-rod and restoring it to normal position when re-

leased and means for releasing the movable jaw upon the descent of the carbon-rod, substantially as set forth.

13. A carbon-clutch for electric-arc lamps, constructed as follows: a fixed jaw mounted on a support and formed from a sheet-metal blank with a concave edge to bite the carbon, and depending perforated ends, a U-shaped oblong frame formed from a rod, a cross-piece secured to the ends of the U-shaped frame, a set-screw in said cross-piece at the rear of and abutting against the rear end of the fixed jaw, a movable jaw formed from a sheet-metal blank and consisting of an arm constituting a thin vertical strip, a flat portion at one end of the latter bent at a right angle thereto and having a curved edge to bite the carbon, and notches at its rear through which passes the outer end of the U-shaped frame serving as a fulcrum on which the movable jaw rocks; and a spring and stop at the outer end of the arm of the movable jaw connected with the support of the fixed jaw, whereby the movable jaw is held in engagement with the carbon-rod, and released therefrom in the vertical movements of the clutch.

14. In an electric-arc lamp, the combination of a resistance-coil, a number of radially-disposed blocks of insulation having beveled or inclined ends and separated from each other and their support by an air-space, notches cut therein for the reception of the resistance-wire, and beveled or inclined clamps for securing the blocks of insulation in place.

15. In an electric-arc lamp, the combination of a resistance-coil, a central support, blocks of refractory insulating material radially disposed around the support but separated therefrom by an air-space, beveled clamping-surfaces on the ends of the blocks, and top and bottom plates secured to the central support, which engage the beveled clamping-surfaces of the insulating-blocks.

16. As an article of manufacture, a clutch for an arc-lamp comprising a punching having a gripping-surface formed integral therewith and mounted on a support extending at right angles thereto, a second punching pivoted to a frame carried by the first at a point substantially opposite its gripping-surface and acting as a movable gripping-surface, and an arm formed integral with one of the punchings, which passes under that punching and also the one opposite thereto; the said arm acting to trip the clutch.

17. As an article of manufacture, an element of a clutch comprising a sheet-metal punching, having an extension 1 with a gripping-surface 2, slots 3, 3; a tongue 4, and an arm or extension H'.

18. As an article of manufacture, the sta-

tionary element of an arc-lamp clutch comprising a metal punching, having downwardly-projecting extensions *e, e*, containing holes 7, 7 for receiving the support for the moving element of the clutch, and a gripping-surface 8 which is formed integral with the main body of the punching between the extensions.

19. In an electric-arc lamp, the combination of a frame having a closed, or practically closed, bottom, a casing having ventilating-openings, which surrounds the bottom, the said openings being located below the bottom, and an ornamental ring extending around the casing and forming a chamber which communicates with the ventilating-openings.

20. In an electric-arc lamp, the combination of a frame having a closed bottom, a casing which surrounds and extends below said bottom and is provided with ventilating-openings, an ornamental ring open on its top side, extending around the casing and forming a chamber which communicates with the ventilating-openings, and a second ornamental ring arranged to flare outwardly and cover the open end of the first-named ring.

21. In an electric-arc lamp, the combination of a screw-threaded projection having a vertical slot therein, a globe-holder mounted for movement on the projection, and a means secured to the globe-holder and working in the slot for preventing the holder from turning.

22. In an electric-arc lamp, the combination of a screw-threaded projection having a vertical slot therein, a globe-holder mounted for movement on the projection, and a nut for raising and lowering the globe-holder.

23. In an alternating-current apparatus, the combination of a magnet-coil adapted to carry alternating current, a flexible support therefor, a guide for directing the movements of the coil, an armature located within the influence of the magnet-coil, and a flexible support for the armature, whereby humming and vibration of the parts are prevented.

24. In an alternating-current apparatus, the combination of a solenoid-magnet adapted to carry alternating current, a support for the parts of the apparatus, a spring between the magnet and the support, a guide for directing the movements of the magnet, a laminated armature arranged to work with the magnet, and a spring-suspension for the armature, whereby humming and vibration of the parts are prevented.

In witness whereof we have hereunto set our hands this 16th day of October, 1897.

ELIHU THOMSON.

CHARLES E. HARTMAN.

Witnesses:

JOHN W. GIBBONEY,

HENRY O. WESTENDARP.

No. 667,128.

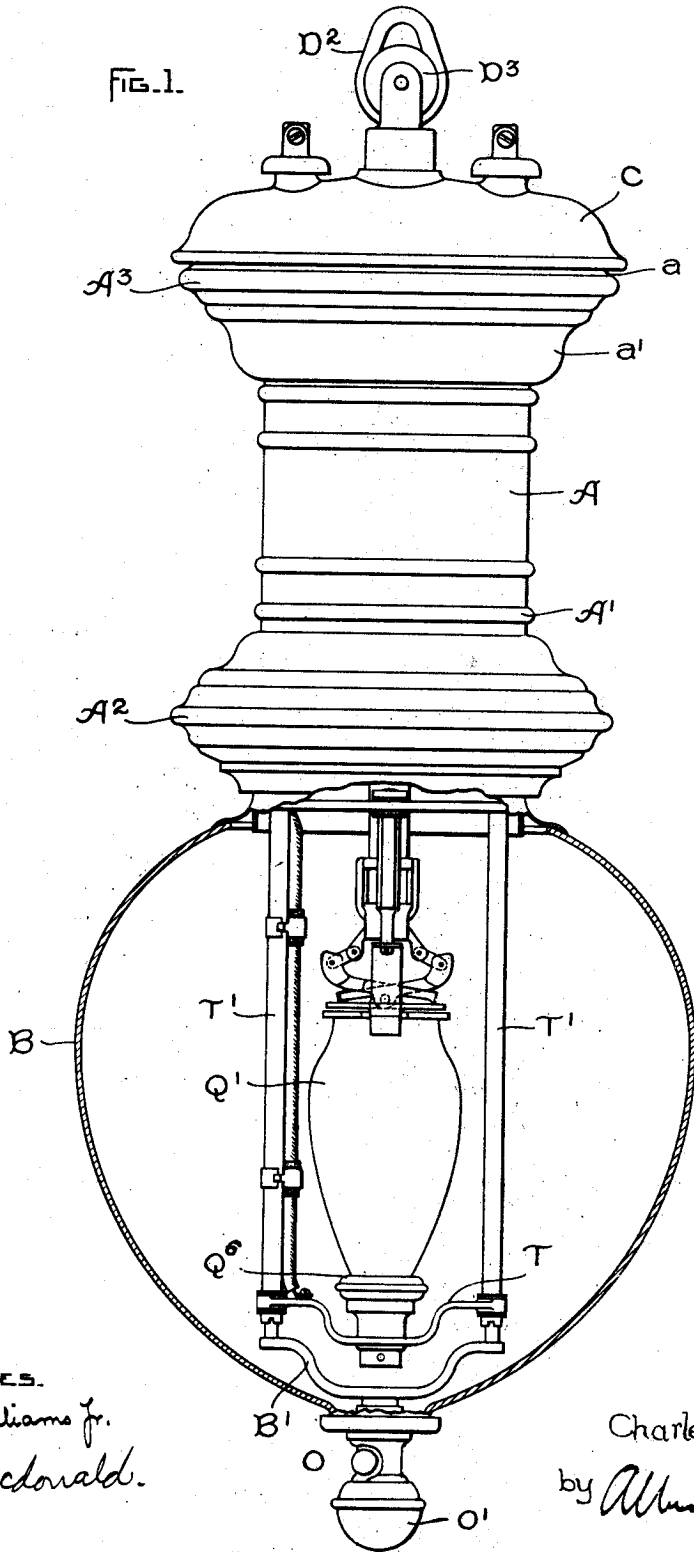
Patented Jan. 29, 1901.

C. E. HARTHAN.  
ELECTRIC ARC LAMP.

(Application filed July 27, 1898.)

(No Model.)

4 Sheets—Sheet 1.



WITNESSES.  
Edw Williams Jr.  
W. McDonald.

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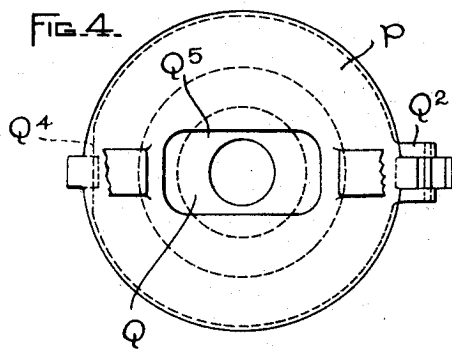
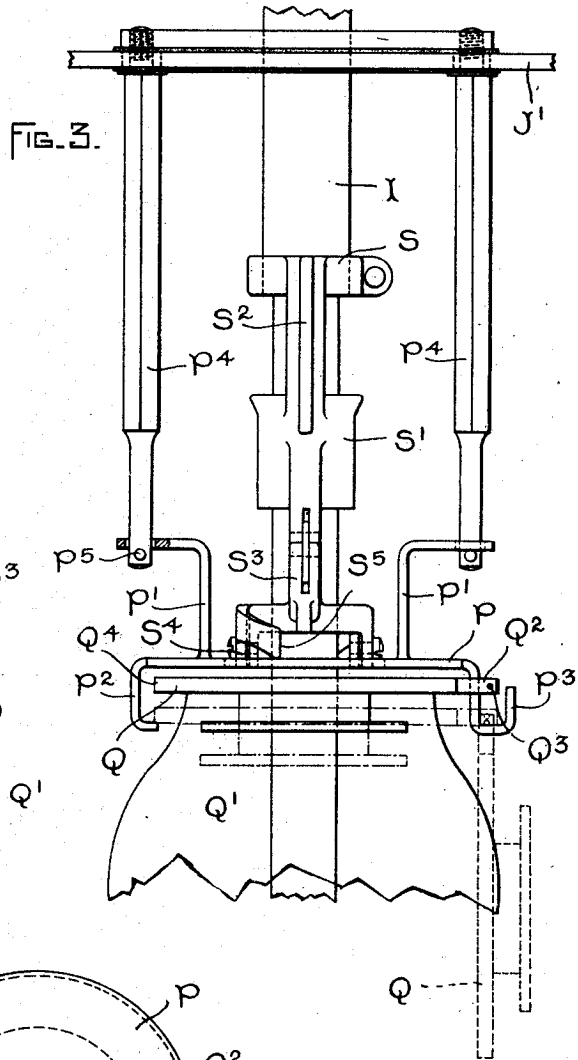
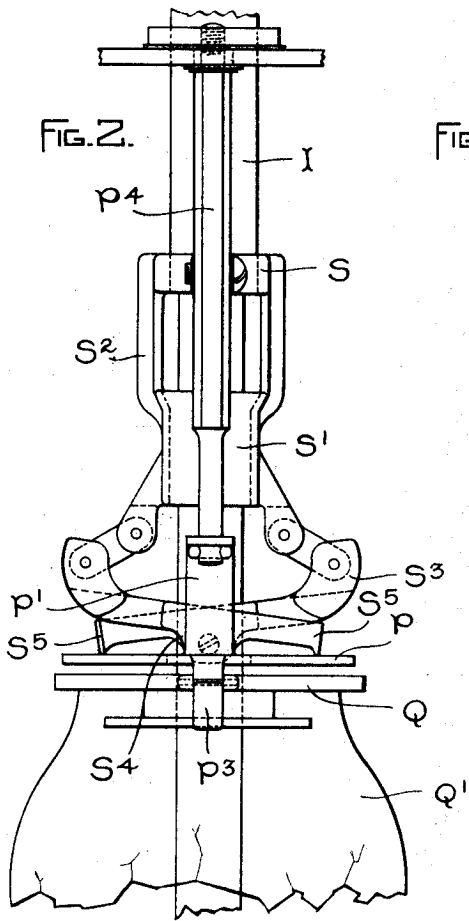


C. E. HARTHAN.  
ELECTRIC ARC LAMP.

(Application filed July 27, 1898.)

(No Model.)

4 Sheets—Sheet 2.



WITNESSES.  
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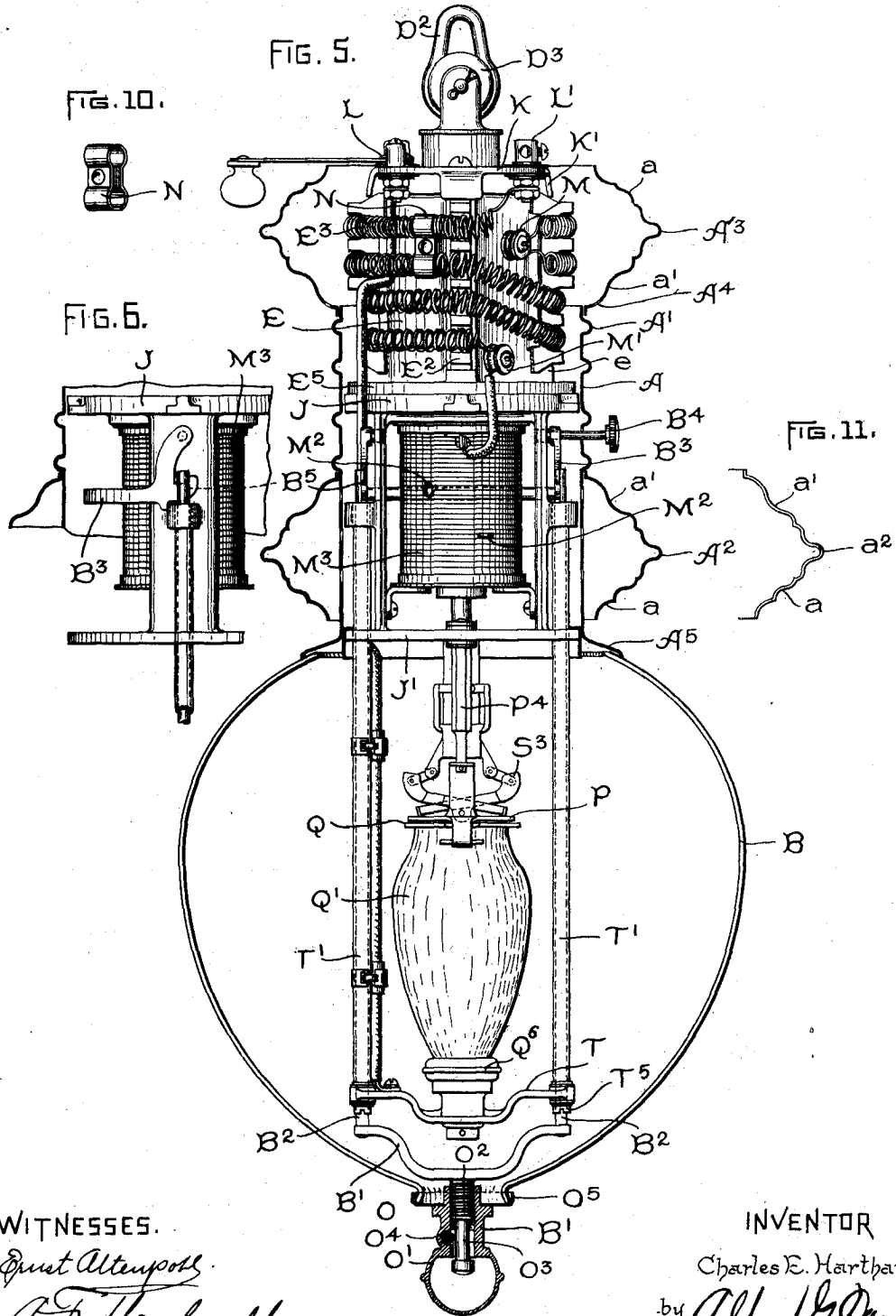
INVENTOR.  
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C. E. HARTHAN.  
ELECTRIC ARC LAMP.

(Application filed July 27, 1898.)

(No Model.)

4 Sheets—Sheet 3.



WITNESSES.

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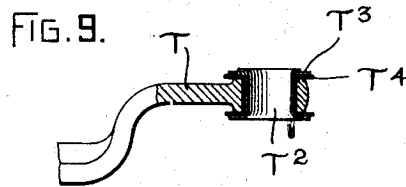
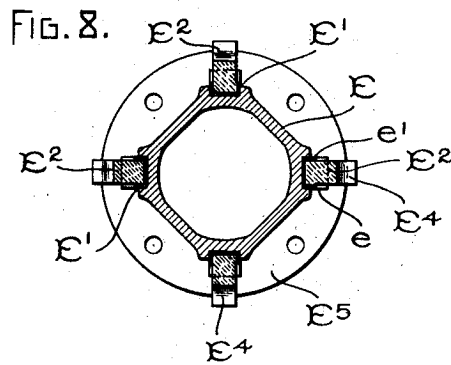
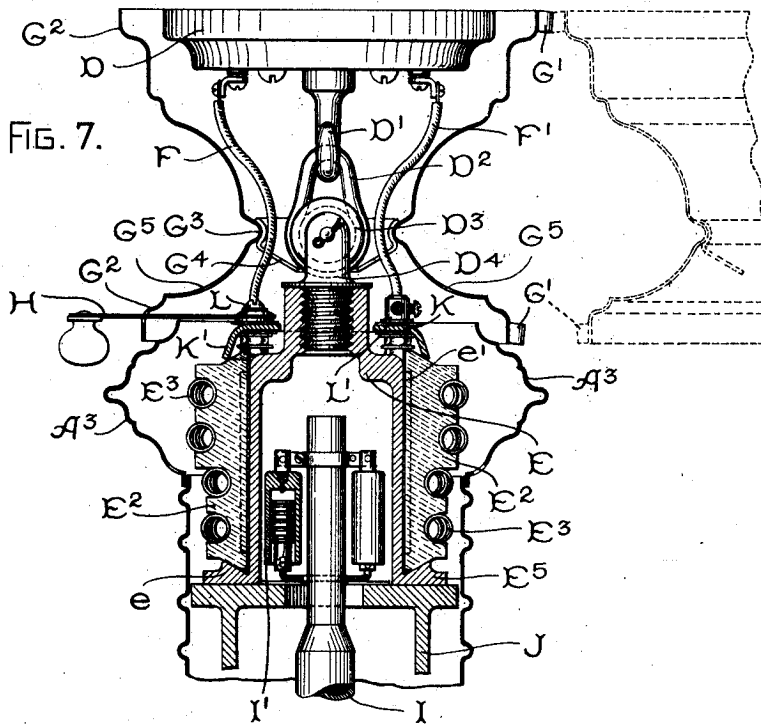
by *Albert G. Davis*  
Atty.

C. E. HARTHAN.  
ELECTRIC ARC LAMP.

(Application filed July 27, 1898.)

(No Model.)

4 Sheets—Sheet 4.



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by *Albert G. Davis*  
Atty.

# UNITED STATES PATENT OFFICE.

CHARLES E. HARTHAN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE  
GENERAL ELECTRIC COMPANY, OF NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 667,128, dated January 29, 1901.

Application filed July 27, 1898. Serial No. 686,978. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES E. HARTHAN, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, (Case No. 788,) of which the following is a specification.

My invention relates to arc-lamps, and has for its object to improve their construction; and to this end it consists in the parts and combination of parts hereinafter described and claimed.

In the accompanying drawings, which show an embodiment of my invention, Figure 1 is a front elevation of a lamp with the outer globe in section. Fig. 2 is a side elevation of the mechanism employed to support the cylinder-cap. Fig. 3 is a front elevation of the same. Fig. 4 is a plan view of the cap-support with portions broken away. Fig. 5 is a front elevation of a lamp with the globe and casing in section. Fig. 6 is a detail of the globe-locking device. Fig. 7 is a sectional detail of the resistance-supporting frame and also of the canopy. Fig. 8 is a detail of the resistance-support. Fig. 9 is a detail illustrating the means employed in insulating the side rods. Fig. 10 is a perspective view of a resistance-slide. Fig. 11 shows the shape of the cornice of the lamp-casing.

In manufacturing arc-lamps it is desirable from a selling point of view to make them attractive, and it is necessary to construct them as cheaply as possible. The mechanism of the lamp is usually surrounded by a casing, and in order to make this casing as cheaply as possible I construct it of sheet metal and make it into the form of a cylinder A, having suitable bands or ornamentations A', formed by rolling the sheet metal of which it is composed between rolls during the process of construction. The lower end of the casing is perforated, as shown, to permit ventilation and keep the parts cool. Mounted on the ends of the cylinder A are cornices A<sup>2</sup> and A<sup>3</sup>. These cornices are similar in construction and are formed by the same formers. As it is necessary to ventilate the lamp-casing, the side *a* of the lower cornice is made a trifle shorter than the side *a'*, so that air can enter at a point above the outer globe B and pass

upward through the lamp parts, thereby keeping the temperature of the lamps down to a predetermined amount.

In Fig. 11 is shown the construction of the cornices. For convenience and cheapness of construction the cornices are made of two pieces *a* and *a'*, which lap over each other at point *a*<sup>2</sup>. The two pieces are formed separately and are afterward secured together by spinning, which makes a water-tight joint between them. In so far as the construction of the cornices is concerned it does not matter whether they are provided with side portions *a* and *a'* of the shape and length shown or not, the essential feature being to make the cornice in two parts and to secure them in the manner shown. The side *a'* of the cornice is secured to the casing A in any suitable manner—as, for example, by riveting or soldering. The upper cornice A<sup>3</sup> is reversed with respect to the lower one and extends above the casing A and is secured in place by riveting or soldering the long side *a'* to the casing. The upper cornice commonly surrounds a resistance in a direct-current lamp and a reactance in an alternating-current lamp, and for ventilating the resistance or reactance the long side *a'* of the cornice A<sup>3</sup> is perforated by a series of small holes A<sup>4</sup>, as shown in Figs. 5 and 7.

When the lamp is intended for out-of-door service, a metal cover C is provided resembling an inverted saucer, which extends down over the short side *a* of the upper cornice and prevents water from entering the casing. By making the cornices similar and reversing the upper one sufficient room is provided at the top for the resistance or reactance, and the size of this resistance or reactance may be varied without altering the size of the casing. This makes all of the lamps present a uniform appearance whether they are intended for alternating or continuous current.

When a lamp is intended for indoor use, where ornamental appearance is an important feature, the arrangement shown in Fig. 7 is employed. Secured to the ceiling or other suitable support is a ceiling-board D, made of insulating material and preferably of non-combustible material—as porcelain, for example. On the under side of the board is

a hook D', arranged to support the lamp by the ring D<sup>2</sup>, which ring is insulated from the lamp by the bushing D<sup>3</sup>. The bushing is mounted in a U-shaped casting D<sup>4</sup>, which is screw-threaded to the resistance-supporting dome E. Electrical connection between the hanger-board and the lamp is made by the cables F and F'.

Surrounding the ceiling-board, cables, and hook is a split canopy, so arranged that one-half of it may be swung outward on hinges G' to permit inspection and also to permit the removal of the lamp. The canopy is provided with enlarged heads G<sup>2</sup> and a contracted neck G<sup>3</sup>, the upper head surrounding the ceiling-board D and the lower head the cornice A<sup>3</sup>. The lower head is slotted to receive the actuating-handle of the switch H. Secured to the neck of the canopy is an internal flange or collar G<sup>4</sup>, which closely surrounds the U-shaped casting D<sup>3</sup>, suitable openings being provided for the reception of the cables F and F'. This prevents the heat from passing upward to the ceiling. The heat passes outward from the casing through the space between the upper cornice A<sup>3</sup> and the canopy and also through the holes G<sup>5</sup> in the canopy.

It will be seen that the canopy projects downward over the cornice, so that the lamp presents an unbroken ornamentation from the globe to the ceiling, a feature which adds greatly to the appearance of the lamp.

In direct-current lamps designed for constant-potential circuits it is customary to mount a resistance in the top of the lamp, and for this purpose a cast-metal dome E is provided, having radial slots E' for the reception of the blocks of insulating material E<sup>2</sup>, which carry the resistance-coil E<sup>3</sup>. The dome is made hollow in order to radiate the heat generated by the resistance-coil and also to receive certain of the operating parts of the lamp. In the present instance the upper end of the tube I and the dash-pot I' are within the dome. On the lower end of the dome is a cylindrical flange E<sup>5</sup>, adapted to be secured to the lamp-frame J by screws.

Situated at the bottom of the insulating-blocks E<sup>2</sup> and formed integral with the flange E<sup>5</sup> are beveled lugs or projections e, arranged to secure the blocks at their lower end. The blocks E<sup>2</sup> are preferably made of porcelain or other non-combustible material and are provided with openings E<sup>4</sup> for the reception of the resistance-coils E<sup>3</sup>. Between the blocks and the slots E' in the dome are strips of asbestos or similar material e', which compensate for any slight irregularities in the parts and at the same time assist in retaining the blocks in place. The insulating-blocks are secured in place at the top by a plate K, having downwardly-projecting feet K', which rest upon the upper beveled ends thereof. The plate also acts as a support for the binding-posts L and L' and is secured to the dome by screws.

Referring more particularly to Fig. 5, the method of winding the resistance will be described. The resistance-wire is first coiled like a helical spring and the spring wound around the dome. The outer end of the resistance is connected to the binding-post L' and is wound in an anticlockwise direction until it arrives at the insulating-bushing M, where it is given half a turn, and the balance of the coil wound in a clockwise direction and finally secured to insulating-bushing M'. The inner end of the resistance is so arranged that it may be connected to any one of the loops M<sup>2</sup> formed on the magnet-winding M<sup>3</sup>. This is to adapt the lamp for use on different circuits or for different currents.

In order to adjust a lamp for use on different circuits, it is often necessary to change the amount of resistance in circuit therewith, and for this purpose a two-part clamp or slider, Fig. 10, is provided and so arranged that it may be slid along two turns of the coil and cut out more or less resistance. By arranging the resistance-coil in such manner that part is wound in one direction and part in the reverse direction a wide range of regulation by the resistance is obtained. When the clamp N is in the position shown, current in passing from the coil M<sup>3</sup> to binding-post L', or vice versa, is practically shunted past two turns of the resistance-wire, whereas if the clamp N is placed across the two lower turns only a single turn of resistance is cut out. Sliding the clamp along the wire will of course vary the amount of resistance in circuit.

The arrangement of the resistance-wire and its supports is a particularly desirable one, for it permits the adjusting of the wire after it has been mounted in place, and where the turns of wire of which the resistance is composed are close together this is an important feature.

In order to prevent carelessness on the part of the trimmer, the globe B is carried by a holder B', which is secured to the lower ends of rods B<sup>2</sup>, and the rods in turn are locked in their raised position by the pivoted bail B<sup>3</sup>. The bail is controlled from the outside of the casing by the thumb-nut B<sup>4</sup>. This necessitates the use of both hands when the globe is lowered, for the globe has to be raised slightly before the hook-shaped end of the latch B<sup>3</sup> can be withdrawn from the openings B<sup>5</sup> in the side rods.

To prevent the entrance of water into the outer globe B, a cylindrical flange A<sup>5</sup> is mounted on the lower end of the casing A, which flares outward over the opening in the globe. In order to make a tight joint between the flange and the globe and also to compensate for different-sized globes, the globe is supported by an adjustable holder O, which in the present instance comprises a cast-metal holder O', having a loosely-fitting cup-shaped ring O<sup>5</sup> at its upper end for receiving the globe. By making the ring O<sup>5</sup> a loose fit

the holder O may be rotated without turning the globe. The holder is supported from cross-piece B' by a screw-threaded stud O<sup>2</sup>, having a cut-away portion O<sup>3</sup>, and extending across this cut-away portion is a pin O<sup>4</sup>, which prevents the removal of the support, but permits it to be freely adjusted in a vertical direction.

In retrimming the lamp the holder O is first turned in a direction to lower the globe. The globe and holder are then moved bodily upward, which permits the withdrawal of the hooked latch B<sup>3</sup>, and after this has been done the globe may be lowered in the usual way. To return the parts of the lamp to their normal position after retrimming, the reverse of the operation is performed.

In retrimming lamps it frequently happens that the trimmer will drop the cap for the inner cylinder, and thus break the outer globe. When the cap is cold, this is not so liable to happen; but when the cap is too hot to be taken in the hand and it is necessary to use pliers or some similar device there is great liability of accident. To guard against this, the cap is permanently secured to the lamp, but is so arranged that it may be removed from its normal position when it is desired to insert a new carbon in the upper holder. Since it is desirable to have the floor of the clutch which controls the feed of the upper carbon located at a fixed point with respect to the working parts of the lamp, I provide a fixed support which constitutes a floor for the clutch and at the same time serves to prevent the cylinder-cap from dropping.

Referring more particularly to Figs. 2, 3, and 4, the support consists of a flat metal plate P, having two upwardly-extending lugs P' and two downwardly-extending lugs P<sup>2</sup> and P<sup>3</sup>, lug P<sup>2</sup> being arranged to support the free end of the cylinder-cap Q after the cylinder Q' has been removed and lug P<sup>3</sup> to form a hinge-support for one side of the cap. The support P is retained in place by two vertically-extending rods P<sup>4</sup>, which are screw-threaded to the under side of the frame J'. The holes in the outer ends of the lugs P' are large enough to make an easy fit, so as to permit the support to adjust itself, and by taking out the pins P<sup>5</sup> the support may be removed from the lamp. The arrangement of the support P and the rods P<sup>4</sup> is such that the support is practically capable of universal motion—that is to say, there is enough play between the parts so that the support can tilt both on a horizontal and a vertical axis.

The clutch is secured to the lower end of the tube I and consists of a pair of collars S and S', which are connected by side bars S<sup>2</sup>. Pivotaly secured to the lower collar S' is a pair of clutch members S<sup>3</sup>, arranged to grip the upper carbon and feed it downward as the carbons are consumed. The clutch members are provided with extensions S<sup>5</sup>, arranged in such manner that they will, when the tube I is lowered a certain amount, strike the top

of the support P and trip the clutch. By referring to Fig. 4 it will be seen that the support P is provided with a rectangular central opening Q<sup>5</sup>. This opening is arranged to receive the downwardly-extending lugs S<sup>4</sup> of the clutch members, thereby shortening the space required by the clutch. The opening between the collars S and S' of the clutch is so arranged that the carbon can be held by the fingers or pliers, or the contact device secured to the end of the carbon can be held while the carbon is inserted in place.

The cylinder-cap Q is substantially circular in outline and is provided with a U-shaped lug Q<sup>2</sup> on one side, which extends around the lug P<sup>3</sup> on the support, and the ends of the lug are connected by a pin Q<sup>3</sup>. The cap is provided with two circular flanges, the upper one being arranged to rest on the top of the cylinder Q', while the lower one is somewhat smaller than the cylinder and forms, together with the cylinder, a gas-chamber for preventing the free entrance of air at this point. The cap is normally supported by the cylinder Q', as shown by the full-line position; but when it is desired to retrim the lamp the cylinder-holding device Q<sup>6</sup> is released and the cylinder lowered until the cap rests on the lugs P<sup>2</sup> and P<sup>3</sup> in the manner shown in the broken and dotted lines, Fig. 3. The upper carbon is then raised, either by hand or with a pair of pliers, which permits the cap to be moved slightly to the right, and the flattened edge of the cap Q<sup>4</sup> will slip past the end of the lug P<sup>2</sup> and permit the cap to drop to the position shown in dotted lines, Fig. 3, the pin Q<sup>3</sup> preventing it from dropping. With this arrangement the cap is out of the way and does not interfere with the retrimming of the lamp and at the same time is prevented from dropping and breaking the globe. After the new carbons have been placed in the lamp the cap is placed in the broken and dotted line position and the cylinder mounted in place, which moves the cap upward to the full-line position.

It is necessary in certain types of lamps to insulate the lower-carbon holder from the side frames, and it has been a matter of considerable difficulty to provide a satisfactory construction. In Fig. 9 the construction is shown in detail, in which T represents the frame connecting the side tubes T', (the latter are shown in Fig. 5,) and it is provided with a hole or opening at its outer end for the reception of the tube. Mounted within the hole is a metal bushing comprising a main body T<sup>2</sup> and a washer T<sup>3</sup>. Between the metal bushing and the frame is an insulating-bushing T<sup>4</sup>, preferably composed of mica, but other forms of insulating material may be used, if desired. The metal and insulating bushings are secured in place by riveting the main body T<sup>2</sup> of the metal bushing over the washer T<sup>3</sup>. The frame T is secured to the side tubes by means of the hollow screws T<sup>5</sup>. The arrangement above described is particularly useful where

it is desired to remove the frame T, for the insulation is so arranged that it is not disturbed and the metal bushing makes a good working fit with the tube. With other constructions previously employed it was necessary to use a new insulating-bushing each time the lamp was taken down, whereas with the present construction a single bushing lasts as long as the lamp.

10 What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric-arc lamp, the combination of an actuating-magnet, a device for steadying the action of the lamp, a frame for carrying the device which is located above the magnet, a circular casing for the magnet which is provided with ventilating-openings admitting air to that portion of the casing surrounding the magnet, an annular cornice secured to the upper end of the case and surrounding the steadying device, the said cornice being open at its upper end; a second annular cornice like the first, but reversed with respect thereto, the said cornice being secured to the casing at its upper end, but standing away from it at its lower end to permit air to freely enter the ventilating-openings, at the same time preventing dirt from passing into the openings.

2. The combination of an electric-arc lamp, a fixed support, means extending between the support and the lamp for sustaining the latter, a split canopy which surrounds the support and said means and is provided with a restricted neck and two enlarged or flaring ends, and an internal flange or collar secured to the canopy which closely surrounds the lamp-sustaining means.

3. The combination of a hanger-board, an arc-lamp, means for supporting the lamp from the board, a canopy which consists of a split cylindrical body having a restricted neck and two outwardly-flaring end portions, one of which surrounds the hanger-board, the other the lamp, the latter end being provided with ventilating-holes and a collar or flange secured to the inside of the canopy for directing the hot air from the lamp out through the ventilating-openings and preventing it from passing up to the hanger-board.

4. In an electric-arc lamp, the combination of a ceiling-board, means for supporting the lamp, a split canopy surrounding the support and comprising a metal cylinder having a contracted neck and outwardly-flaring ends, and a split internal collar or flange which prevents the heat from passing upward from the lamp to the ceiling-board.

5. In an electric-arc lamp, the combination of a ceiling-board, means for supporting the lamp, a split canopy surrounding the support and comprising a metal cylinder having a contracted neck and outwardly-flaring ends, a split internal collar or flange which is secured to the neck and prevents the heat from passing upward from the lamp, the split in the canopy and in the collar coinciding, and ventilat-

ing-openings permitting the free egress of heated air from the lamp.

6. In an electric-arc lamp, the combination of a supporting resistance-dome, a frame to which the dome is secured, a coiled resistance-wire one portion of which is wound in a clockwise direction, and a second portion wound in an anticlockwise direction around the dome, insulating-blocks mounted on the dome which serve to separate the resistance from the dome and at the same time hold the turns of the resistance-coil in fixed relation to each other, and a contact device for establishing electrical connection with the resistance.

7. In an arc-lamp, the combination of a cast-metal resistance-dome, notched radial blocks mounted thereon, a coiled resistance-wire mounted on the blocks, the arrangement of the coils being such that one part of the wire is wound in a clockwise direction and the balance in an anticlockwise direction, and an adjustable slider mounted on the resistance-wire for varying its active length.

8. In an electric-arc lamp, the combination of a metal resistance-dome having beveled lugs formed at the base, a detachable support at the top of the dome having downwardly-extending feet, notched insulating-blocks mounted in the dome and secured in place by the feet and beveled lugs, and a resistance-wire coiled in the notches in said blocks.

9. In an electric-arc lamp, the combination of a metal resistance-dome having a flange at its lower end formed integral therewith, beveled lugs on the flange, a sheet-metal support located at the top of the dome and having downwardly-extending feet, insulating-blocks mounted on the dome between the feet and the beveled lugs, and a layer of non-combustible material between the blocks and the dome, which serves to compensate for slight irregularities.

10. In an arc-lamp, the combination of a resistance-dome, insulating-blocks mounted thereon, coiled resistance-wire wound thereon in spirals, the arrangement being such that one part of the wire is wound anticlockwise and the balance clockwise, means for holding the resistance at the point of turning, means for securing the outer ends of the wire, and a sliding contact arranged to bridge more or less of two turns of the coil.

11. In an electric-arc lamp, the combination of a globe-holder, a locking device therefor, means for limiting the upward movement of the globe, and means for adjusting the globe so arranged that it is necessary to lower the globe slightly before the lock can be released.

12. In an electric-arc lamp, the combination of a globe-holder, a locking device therefor, and means so arranged that it is necessary to lower the globe slightly before the lock can be released.

13. In an electric-arc lamp, the combination of a globe, a vertically-adjustable support for the globe, a lock for securing the globe in po-

sition, and means for raising the globe slightly against a stationary part of the lamp so as to prevent the entrance of water and dirt into the globe, the relation of the globe-holder and the lock being such that it is necessary to lower the globe-holder slightly before the lock can be released.

14. In an electric-arc lamp, the combination of a globe, a globe-holder mounted on a screw-threaded stud carried by a suitable frame, an outwardly-flaring flange against which the globe is normally pressed, and a lock for the holder, comprising a moving bail having hooked ends and a pair of vertically-movable side rods; the relation between the lock and the holder being such that it is necessary to slightly lower the globe before the lock can be released.

15. In a globe-holder for an arc-lamp, the combination of a screw-threaded stud, a holder mounted thereon and arranged to be vertically adjustable, means for preventing the holder from being removed from the stud during the normal act of recarboning the lamp, and a loosely-mounted cup-shaped ring for supporting the outer globe, which is so arranged that the holder may be rotated without moving the globe.

16. In an electric-arc lamp, the combination of a cylinder surrounding the carbons, a cap for restricting the passage of air into the cylinder, a frame located above the cap and arranged to hold the cap in substantially its normal position when the globe is removed, and means thereon for holding the cap at one side of its normal position while the lamp is being trimmed.

17. In an electric-arc lamp, the combination of a cylinder surrounding the carbons, a cap which normally rests on the top of the cylinder for restricting the passage of air into the cylinder, a frame for holding the cap after the cylinder has been removed in substantially its normal operating position, and a hook on the frame for sustaining the cap in a downward position and at one side of the carbons while the lamp is being retrimmed.

18. As an article of manufacture, a combined support for a cylinder-cap and the floor of a clutch, comprising a substantially circular plate having an enlarged central opening to receive parts of the clutch, with a pair of upwardly-extending supporting-lugs, and a pair of downwardly-extending cap-retaining lugs.

19. In a carbon-feed electric-arc lamp, the combination of a tube surrounding the carbon, a clutch mounted on the tube, the said clutch comprising two collars in fixed relation to each other having a space between them, and so arranged that the upper carbon can be gripped by hand between them, and clutch members for gripping the carbon which are pivotally secured to one of the collars.

20. In an electric-arc lamp, the combination of a side rod, a yoke having a hole therein through which the rod passes, an insulating-bushing located in the hole between the rod and the yoke, the said bushing comprising a body of insulating material which covers the walls of the hole at all points, and a tubular metal sleeve which extends through the hole and is flanged at its ends to hold the insulation in place, the said sleeve being in direct connection with the side rod.

21. In an electric-arc lamp, the combination of a pair of side rods, a yoke connecting the rods and having holes therein through which the rods pass, an insulating-bushing comprising a body of mica which covers the wall of the hole and also the top and bottom surfaces near the hole, washers which are located above and below the insulation, and a metal sleeve which is riveted over the washers to hold them in place, the said sleeve being in direct contact with a side rod.

22. In an electric-arc lamp, a screw-threaded projection secured to and depending from the lower end of a frame, a holder for supporting the globe from its lower end, which is vertically movable on said projection, and a nut serving to raise and hold the globe and its holder in position.

23. In an electric-arc lamp, the combination of a pair of vertical side tubes forming a support for the lower-carbon holder, rods mounted for vertical movement within the side tubes and arranged to raise and lower the globe, a screw-threaded extension on the piece connecting the rods, a vertically-adjustable globe-supporting device mounted on the extension, means for securing the globe in its raised position, and a lock for said means.

In witness whereof I have hereunto set my hand this 18th day of July, 1898.

CHARLES E. HARTHAN.

Witnesses:

DUGALD MCKILLOP,  
HENRY O. WESTENDARP.

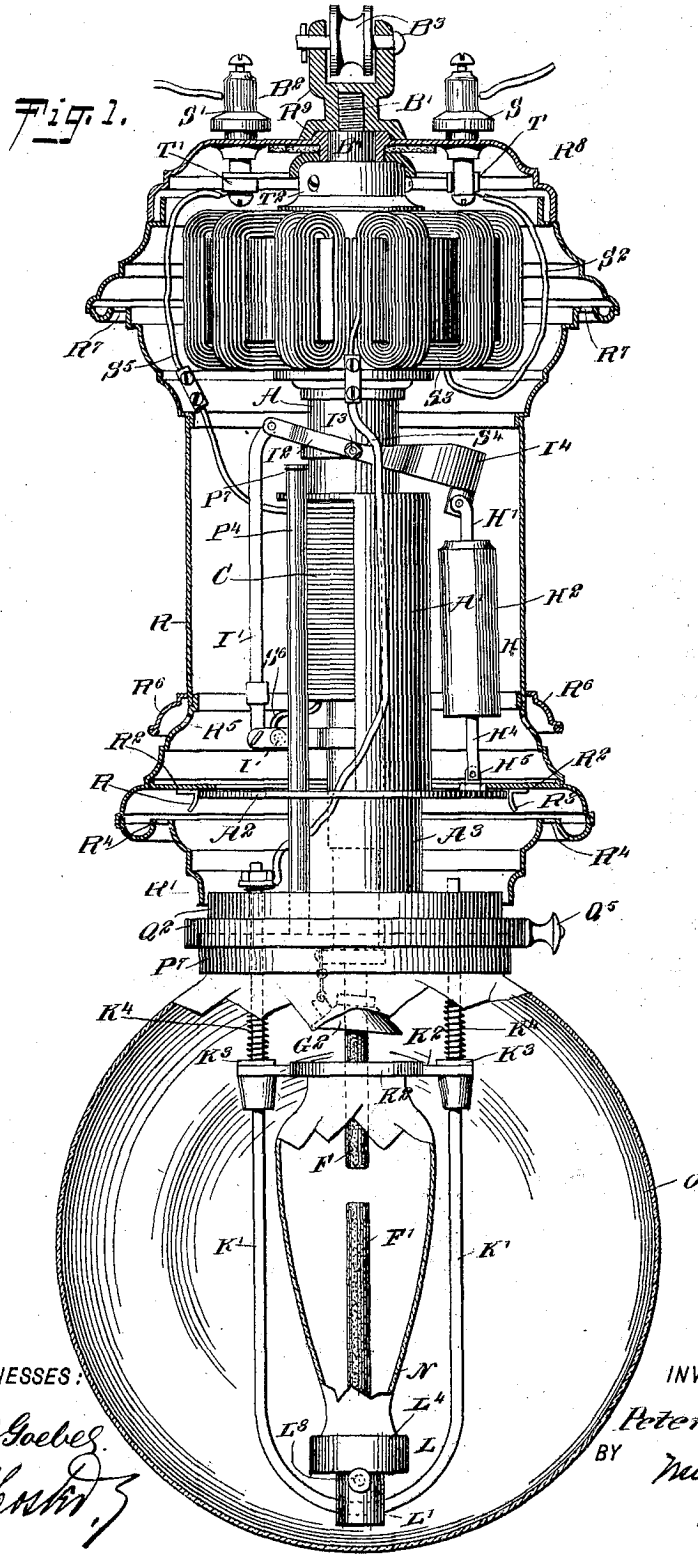


P. H. F. SPIES.  
ELECTRIC ARC LAMP.

(Application filed June 5, 1901.)

(No Model.)

3 Sheets—Sheet 1.



WITNESSES:

*William P. Goebel*  
*Geo. F. Hendon*

INVENTOR

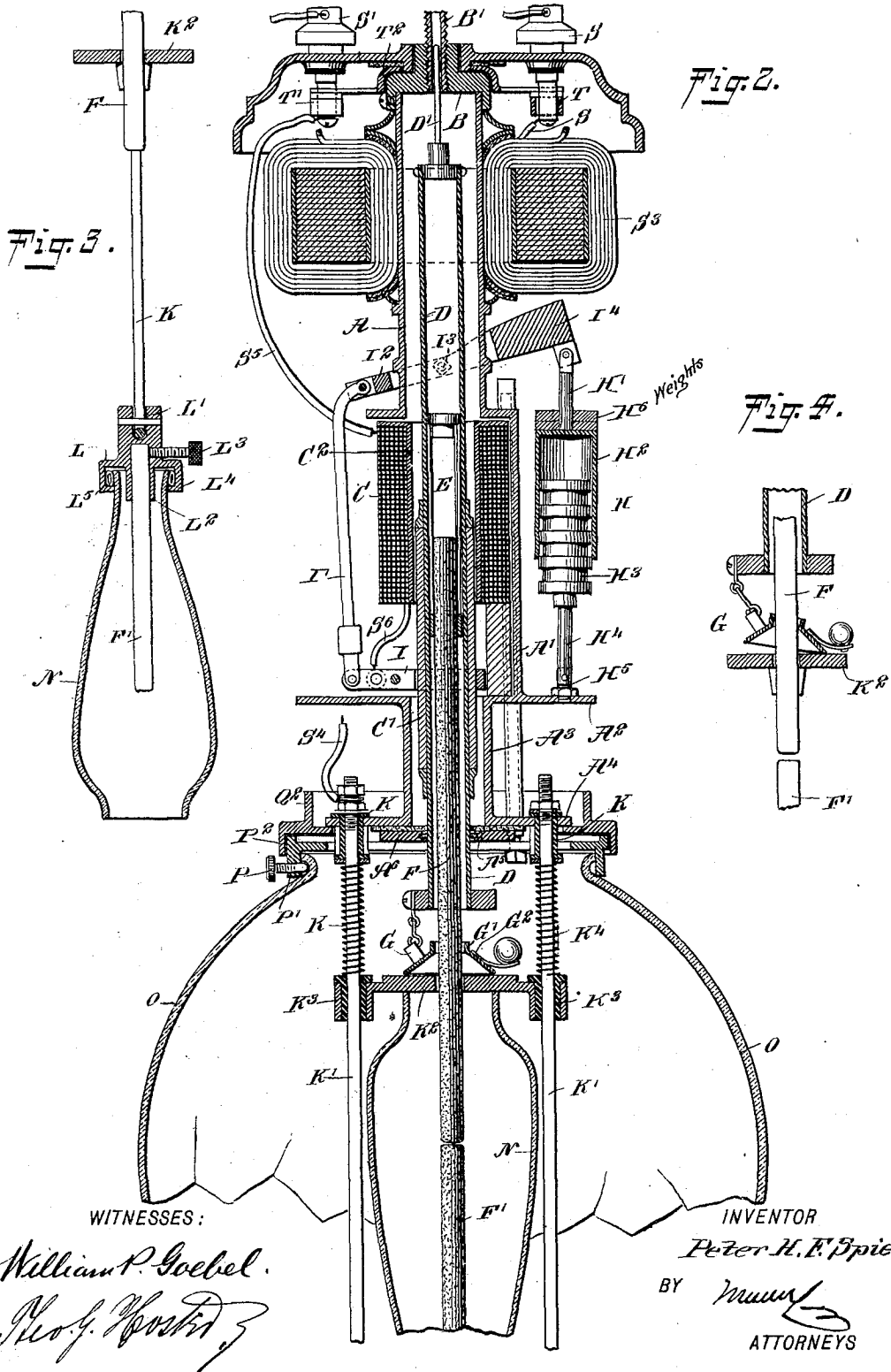
*Peter H. F. Spies*  
 BY *Neumann*  
 ATTORNEYS

P. H. F. SPIES.  
ELECTRIC ARC LAMP.

(Application filed June 5, 1901.)

(No Model.)

3 Sheets—Sheet 2.



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ELECTRIC ARC LAMP.

(Application filed June 5, 1901.)

(No Model.)

3 Sheets—Sheet 3.

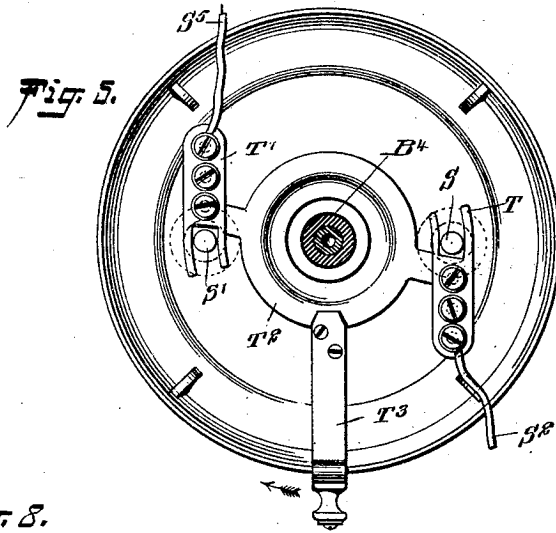


Fig. 5.

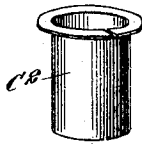


Fig. 8.

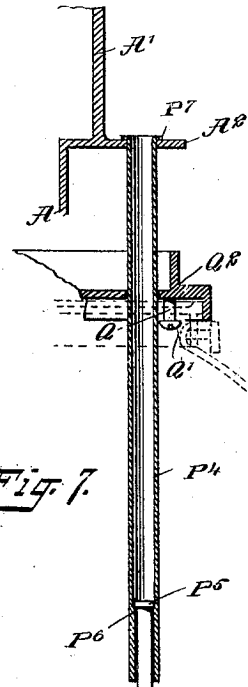


Fig. 7.

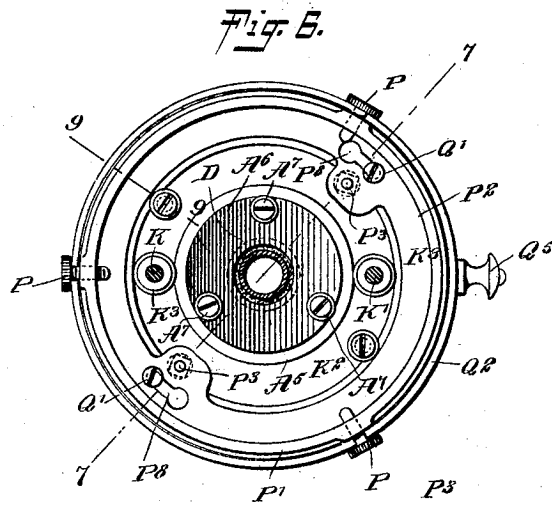


Fig. 6.

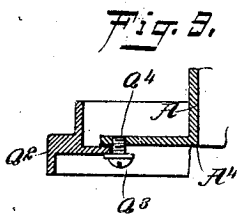
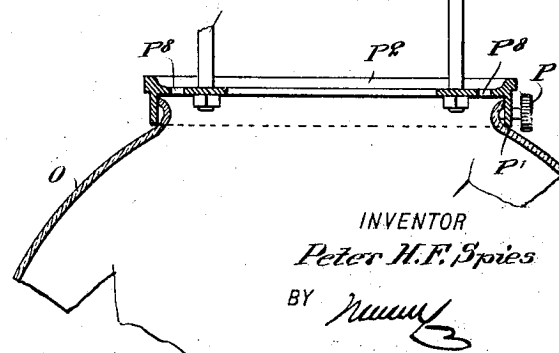


Fig. 9.



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*Peter H. F. Spies*

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 ATTORNEYS

# UNITED STATES PATENT OFFICE.

PETER HEINRICH FELIX SPIES, OF MOUNT VERNON, NEW YORK, ASSIGNOR  
OF ONE-HALF TO JACOB NORDEN, OF MOUNT VERNON, NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 698,575, dated April 29, 1902.

Application filed June 5, 1901. Serial No. 63,216. (No model.)

*To all whom it may concern:*

Be it known that I, PETER HEINRICH FELIX SPIES, a subject of the Emperor of Germany, and a resident of Mount Vernon, in the county of Westchester and State of New York, have invented a new and Improved Arc-Lamp, of which the following is a full, clear, and exact description.

The invention relates to arc-lamps such as shown and described in the Letters Patent of the United States, No. 668,886, granted to me on February 26, 1901.

The object of the invention is to provide certain new and useful improvements in arc-lamps whereby the feeding of the upper carbon is exceedingly sensitive to insure at all times a uniform steady light and to permit convenient adjustment according to the power of the current, the construction of the arc-lamp permitting the attendant to conveniently and quickly open and close the same for removal of the carbon or for making repairs or the like.

The invention consists of novel features and parts and combinations of the same, as will be fully described hereinafter and then pointed out in the claims.

A practical embodiment of the invention is represented in the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a side elevation of the improvement with parts in section and parts broken away. Fig. 2 is an enlarged sectional side elevation of the improvement. Fig. 3 is a sectional side elevation of the globe and lower carbon in a lowermost position for convenient insertion and removal of the carbons. Fig. 4 is a sectional side elevation of the clutch for the upper carbon. Fig. 5 is an inverted plan view of the switch, parts being in section. Fig. 6 is an inverted plan view of the lower cap, parts being shown in section. Fig. 7 is a sectional side elevation of part of the improvement, showing the globe lowered. Fig. 8 is a perspective view of the lining for the solenoid-magnet; and Fig. 9 is a sectional side elevation of the solenoid-ring and its support, the section being on the line 9 9 in Fig. 6.

The main supporting-tube A is secured at

its upper end in a socket B, having a reduced threaded tubular extension B', on which screws an eye B<sup>2</sup>, carrying a pulley B<sup>3</sup> for engagement by a cable, rope, or like support for carrying the lamp. The main tube A is formed with an integral pocket A' for receiving and supporting the magnet C of a solenoid, having its core C' attached to the outside of a tube forming a carrier D, which extends loosely in the main tube A with said core C', as is plainly illustrated in Fig. 2. In the carrier D is removably held a carbon-holder E, similar in construction to the one shown and described in the Letters Patent of the United States above referred to, so that further description of the same is not deemed necessary, it being understood that this carbon-holder E carries the upper carbon F and is free to slide in the carrier D. The upper carbon F is connected by a clutch G with the lower end of the carrier D, said clutch being similar in construction to the one described in the patent above referred to, with the exception that the apertured binding-disk G' has a funnel-shaped extension G<sup>2</sup>.

The carrier D, with the core C', is controlled by the energizing and deenergizing of the magnet C and by the action of a dash-pot H, arranged at one side of the pocket A' and supported on a bottom flange A<sup>2</sup>, integrally formed on said pocket, as is plainly shown in Figs. 1 and 2. The connection between the carrier D, the core C', and the dash-pot H is arranged as follows: An arm I is clamped or otherwise secured to the core C' or to the carrier D below the magnet C, and the outer end of this arm I is pivotally connected by a link I' with one end of a lever I<sup>2</sup>, fulcrumed at or near its middle at I<sup>3</sup> on the main tube A above the pocket A'. The other end of the lever I<sup>2</sup> is provided with a weight I<sup>4</sup> and is pivotally connected with the stem H' of a cylinder H<sup>2</sup>, forming part of the dash-pot H, and in said cylinder H<sup>2</sup> extends a stationary piston H<sup>3</sup>, having its plunger-rod H<sup>4</sup> pivotally connected with a bracket H<sup>5</sup>, attached to the flange A<sup>2</sup> previously mentioned. Now when the magnet C is energized the core C' moves upward in the main tube A, and in doing so the arm I and the link I' impart a swinging motion to the lever I<sup>2</sup>, so that the stem H' and the cylin-

der H<sup>2</sup> are moved downward over the stationary piston H<sup>3</sup>. This downward movement of the cylinder H<sup>2</sup> can be accelerated by weights H<sup>6</sup>, removably held on the top of the cylinder H<sup>2</sup> on the stem H<sup>1</sup>. When the magnet C is deenergized, then the weight of the carrier D, its core C', holder E, and carbon F overbalance the dash-pot H, so that the carrier D and the parts thereon move downward, and in doing so cause a swinging of the lever I<sup>2</sup> in an opposite direction by the action of the arm I and the link I', connected with said lever I<sup>2</sup>. During the swinging motion of the lever I<sup>2</sup> the cylinder H<sup>2</sup> is drawn upward on the stationary piston H<sup>3</sup>; but as the movement of the cylinder on the piston is uniform it is evident that a gradual downward movement of the carrier D, holder E, and upper carbon F takes place to insure a very sensitive feeding of the carbon. By the use of the weights H<sup>6</sup> the resistance of the dash-pot to the up-and-down movement of the carrier can be increased or diminished to suit existing conditions and to at all times insure a sensitive feeding of the carbon and a consequent steady burning of the lamp.

The upper end of the carrier D is provided with a guiding-pin D', engaging the central tubular extension B' as a bearing, to insure a straight up-and-down sliding movement of the carrier D with a minimum of friction. The tube end A<sup>3</sup>, depending from the flange A<sup>2</sup>, is formed at its lower end with a flange A<sup>4</sup>, against the bottom of which rests an asbestos washer A<sup>5</sup>, engaged by a bearing A<sup>6</sup> for the lower end of the tube B to slide in, said bearing A<sup>6</sup> being fastened by screws A<sup>7</sup> to the flange A<sup>4</sup>, as is plainly shown in Fig. 6, and the said bearing contains a flexible binding, preferably of asbestos and set in an annular recess in the bearing to insure proper sliding of the tube B.

On the flange A<sup>4</sup> are held bushings K, of rubber or other insulating material and supporting the upper ends of a U-shaped frame K', engaged at its middle by an eye L' on a double socket L, carrying the lower carbon F' and the inner or small globe N. The top of the latter is engaged by a plate K<sup>2</sup>, having bushings K<sup>3</sup>, of rubber or like insulating material, and held to slide loosely on the frame K', but pressed on by springs K<sup>4</sup>, coiled on the frame-arms to hold the plate K<sup>2</sup> normally in firm contact with the upper end of the globe N. The double socket L has a small socket L<sup>2</sup> (see Fig. 3) receives the lower carbon F', and said lower carbon F' is secured in place by a set-screw L<sup>3</sup>. The large carbon L<sup>4</sup> contains a compressible contact-ring L<sup>5</sup> for engagement by the lower end of the globe N, so as to securely hold the latter in position, said contact-ring L<sup>5</sup> being made of a plurality of helices, which are oval in cross-section and interlocked with one another, as more fully shown and described in the Letters Patent of the United States No. 668,887, granted

to me on February 26, 1901, for an electric switch.

The main globe O for inclosing the carbon-globe N and the carbon-supporting frame K and double socket L is secured at its top flange by set-screws P, screwing in the depending flange P' of a ring P<sup>2</sup>, secured on the lower ends of rods P<sup>3</sup>, telescoping in tubes P<sup>4</sup> and having stop-collars P<sup>5</sup>, adapted to be seated on shoulders P<sup>6</sup>, near the lower ends of the tube P<sup>4</sup>, as is plainly shown in Fig. 7. The tubes P<sup>4</sup> are mounted to slide freely in bearings on the flange A<sup>2</sup>, and the upper ends of said tubes are formed with flanges P<sup>7</sup>, adapted to be seated on the top surface of the flange A<sup>2</sup>, as shown in Fig. 7. The ring P<sup>2</sup> is formed with slots P<sup>8</sup>, enlarged at one end for the entrance of the heads Q' of pins Q, secured to a locking-ring Q<sup>2</sup>, supported by or mounted to turn on the heads Q<sup>3</sup> of screws or pins Q<sup>4</sup>, secured to and depending from the under side of the flange A<sup>4</sup>. (See Fig. 9.) The locking-ring Q<sup>2</sup> has a handle Q<sup>5</sup>, adapted to be taken hold of by the attendant of the lamp to turn the ring Q<sup>2</sup> after the ring P<sup>2</sup> has passed, with its slot P<sup>8</sup>, the heads Q' of the pins Q, so that the latter pass into the narrow portions of the slots P<sup>8</sup> and the ring P<sup>2</sup> then rests on and is supported by the heads Q', the globe O being in an uppermost position. When it is desired to lower the globe O to gain access to the globe N and the carbon F', then the attendant turns the ring Q<sup>2</sup> in an opposite direction to bring the heads Q' in register with the enlarged ends of the slots P<sup>8</sup>, so that the ring P<sup>2</sup> is unlocked and is free to slide downward, the rods P<sup>3</sup> sliding in the tubes P<sup>4</sup>, and the latter sliding upward in the flange A<sup>2</sup> until the flanges P<sup>7</sup> rest on the top of the flange A<sup>2</sup> and the stop-collars P<sup>5</sup> are seated on the seats P<sup>6</sup>. (See Fig. 7.) When this takes place, the ring P<sup>2</sup> is below the lower end of the frame K', so that the attendant now has ready access to the globe N and the plate K<sup>2</sup>, which when pressed upward against the tension of the springs K<sup>4</sup> permits of swinging the globe N into a lowermost position, as shown in Fig. 3. The globe N can now be removed, if desired, from its socket L<sup>5</sup> and a new carbon F' can be inserted in the socket L<sup>2</sup> and secured therein by the set-screw L<sup>3</sup>. The new upper carbon may now also be placed in position in the carbon-holder E, after which the several parts are returned to their normal positions—that is, the globe N, with the double socket, is swung upward on the lower end of the frame K', and then the plate K<sup>2</sup> is engaged with the top of the said globe, after which the operator pushes the globe O and ring P<sup>2</sup> upward to telescope the rods P<sup>3</sup> in the tubes P<sup>4</sup> and to slide the latter upward in their bearings in the flange A<sup>2</sup>. When the ring P<sup>2</sup> moves in an uppermost position, the enlarged ends of the slots P<sup>8</sup> engage the heads Q' of the pins Q, after which the ring Q<sup>2</sup> is turned by the attendant manipulating the handle Q<sup>5</sup> so as to cause

the locking-ring  $Q^2$  to lock the ring  $P^2$  in an uppermost position.

The middle and upper portion of the arc-lamp is inclosed in a casing  $R$ , preferably of sheet metal and reduced at its lower end  $R'$  to closely fit the locking-ring  $Q^2$  at its peripheral surface, as is plainly shown in Fig. 1. A distance above this lower end  $R'$  is formed an inwardly-extending annular flange  $R^2$ , adapted to rest on the flange  $A^2$ , so as to separate the heat-developing portion of the lamp from the solenoid, dash-pot, and adjacent upper parts of the lamp. Spring-lugs  $R^3$  are secured to the flange  $R^2$  to engage the periphery of the flange  $A^2$  and hold the casing  $R$  in a centered position. In the portion of the casing below the flange  $R^2$  are formed ventilating-openings  $R^4$  for allowing the heat rising from the burning carbons to escape to the outside of the casing. The openings  $R^4$  are formed in an inwardly and upwardly bent portion, so as to be free from the effects of the wind and to allow a ready escape of heat at all times. Above the flange  $R^2$  are ventilating-openings  $R^5$  in the wall of the casing  $R$ , and an annular protecting-flange  $R^6$  is secured to the casing and extends over said openings to prevent rain or snow from entering the casing at said opening. Ventilating-openings  $R^7$ , similar to the openings  $R^4$ , are arranged near the top of the casing, so that air can freely circulate in the casing above the flanges  $R^2$  to keep the solenoid and connected parts in proper working condition at all times. The extreme upper end of the casing  $R$  is closed by a cap  $R^8$ , having its hub  $R^9$  engaging the reduced portion  $B^4$  of the socket  $B$ , the eye  $B^2$  screwing down upon the cap to hold said cap securely in place.

On the top of the cap  $R^8$  are secured binding and switch posts  $S S'$ , extending to the inside of the cap  $R^8$  to be engaged by switch-forks  $T T'$ , respectively held on a ring  $T^2$ , mounted to turn in the socket  $B$ , said ring being provided with a handle  $T^3$ , extending to the outside between the cap  $R^8$  and the upper end of the casing  $R$ , so that the operator can take hold of the handle  $T^3$  and turn the same to move the switch-forks  $T T'$  in or out of contact with the inner ends of the binding-posts  $S S'$ . The switch-fork  $T$  is connected by an insulated wire  $S^2$  with a resistance or shock coil  $S^3$ , held on the tube  $A$ , near the upper end thereof, and this resistance is connected by an insulated wire  $S^4$  with one arm of the frame  $K'$ , as is plainly shown in Fig. 1. The other switch-fork  $T'$  is connected by an insulated wire  $S^5$  with the magnet  $C$  of the solenoid, and said magnet is connected by an insulated wire  $S^6$  with the arm  $I$ . Now when the switch is in a closed position, as shown in Figs. 1 and 5, then electrical connection is had from the binding-post  $S$  by way of the switch  $T$ , wire  $S^2$ , resistance  $S^3$ , wire  $S^4$ , frame  $K'$ , double socket  $L$  to the lower carbon  $F'$ ,

and connection is had from the binding-post  $S'$ , switch-fork  $T'$ , solenoid-magnet  $C$ , wire  $S^6$ , clamping-arm  $I$ , core  $C'$ , carrier  $D$ , and holder  $E$  to the upper carbon  $F'$ .

Now when the lamp is lowered and the operator desired to change the carbons, as previously explained, then by shifting the handle  $T^3$  and moving the switch-forks  $T T'$  out of engagement with the inner ends of the binding-posts  $S S'$  the current is positively broken, so that the operator can open and close the lamp and remove or insert the carbons without the slightest danger of personal injury by the electric current.

In order to increase the efficiency or pulling power of the solenoid-magnet  $C$ , I provide the same in its central opening with a lining  $C^2$ , of iron or other suitable metal.

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

1. An arc-lamp provided with a solenoid, a carrier for carrying the carbon and the core of said solenoid, a clutch between the carrier and said carbon, an external dash-pot connected with said carrier, and removable weights for the dash-pot, for increasing or decreasing the resistance of the dash-pot to the movement of the solenoid-core, as set forth.

2. An arc-lamp having a supporting-tube formed with an integral flange, a casing having an inner flange adapted to rest on said tube-flange, to separate the heat-developing part of the lamp from the actuating device for the carbon-feed of the lamp, and lugs on said inner flange for engaging said tube-flange, as set forth.

3. An arc-lamp having a supporting-tube provided with top and bottom bearings, and a carrier for the solenoid-core and mounted to slide in said bearings, the upper end of the carrier being reduced to form a pin engaging the upper bearing, the said lower bearing having a flexible lining for engaging the outside of the tubular carrier, as set forth.

4. An arc-lamp having a central supporting-tube formed with a pocket for the solenoid-magnet, a flange integral with the tube for supporting the casing, and a second integral flange for supporting the lower-carbon holder, as set forth.

5. An arc-lamp having a central supporting-tube formed with a pocket for the solenoid-magnet, a flange integral with the tube for supporting the casing, a second integral flange for supporting the lower-carbon holder, and a bearing on the tube for supporting the resistance-coil, as set forth.

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

PETER HEINRICH FELIX SPIES.

Witnesses:

JOHN J. O'REILLY,  
B. WOODARD.

C. E. HARTHAN.  
ELECTRIC ARC LAMP.  
(Application filed July 24, 1900.)

(No Model.)

2 Sheets—Sheet 1.

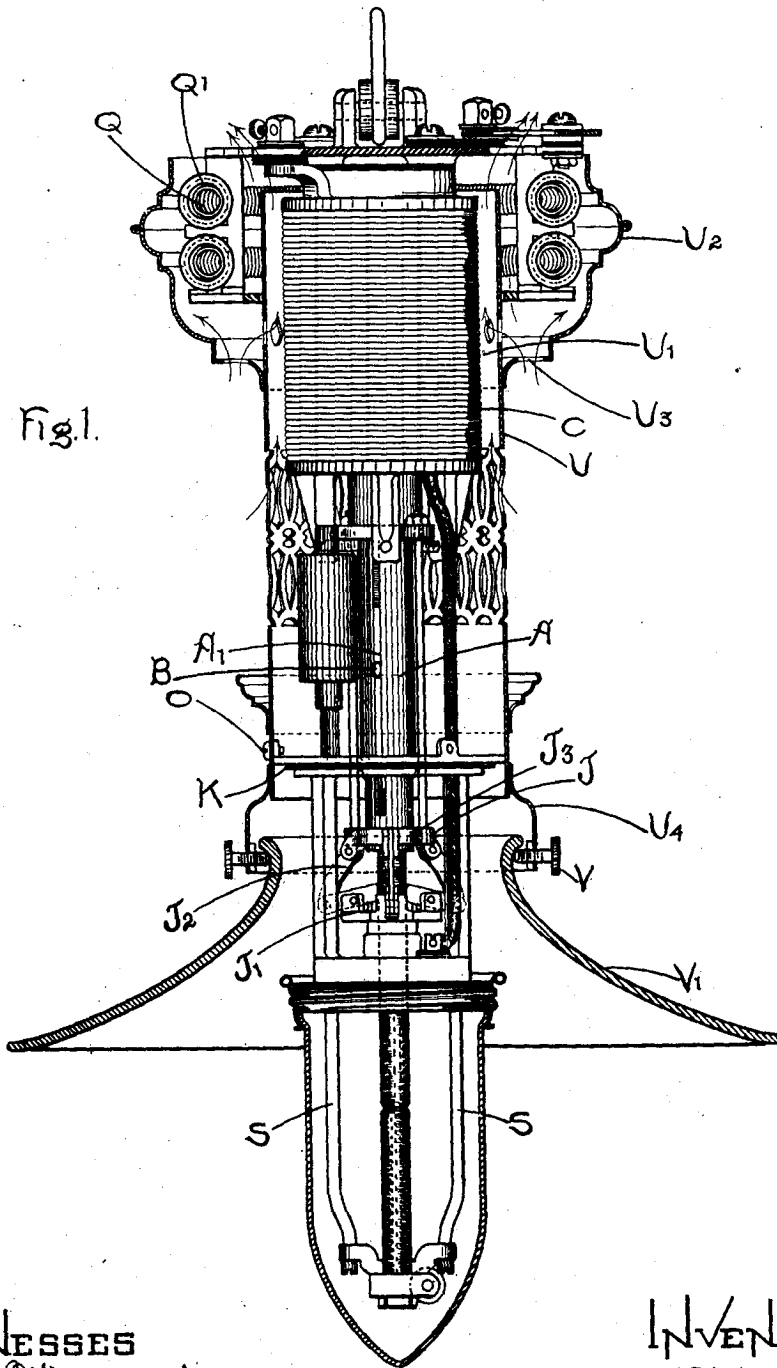


Fig. 1.

WITNESSES  
*Berry Westendorf.*  
*Alex F. Macdonald.*

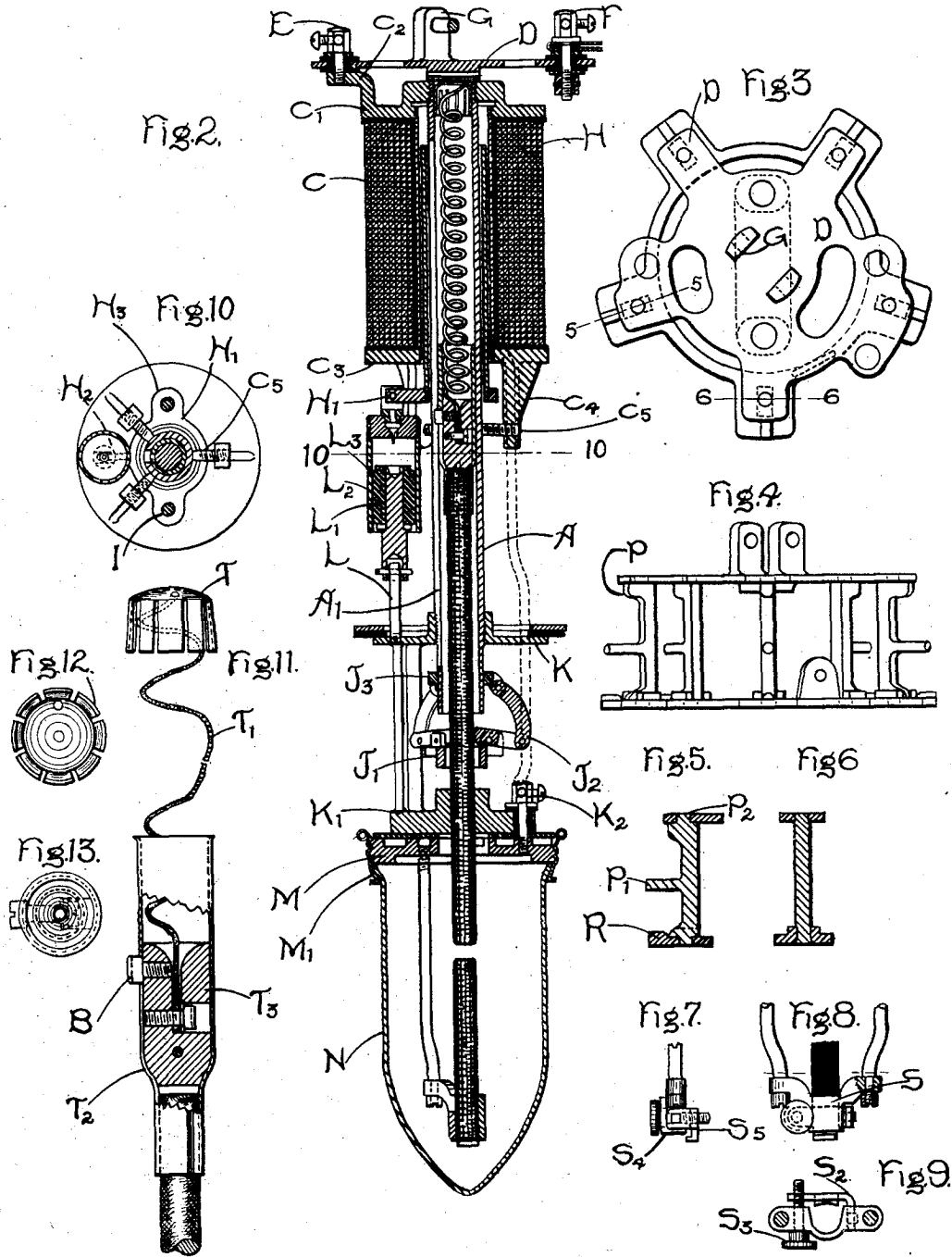
INVENTOR—  
 Charles E. Harthan.  
 by *Albert S. Davis*  
 Atty.

C. E. HARTHAN.  
ELECTRIC ARC LAMP.

(Application filed July 24, 1900.)

(No Model.)

2 Sheets—Sheet 2.



WITNESSES.  
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 Att'y.



# UNITED STATES PATENT OFFICE.

CHARLES E. HARTHAN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE  
GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 710,055, dated September 30, 1902.

Application filed July 24, 1900. Serial No. 24,671. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES E. HARTHAN, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Electric-Arc Lamps, (Case No. 1,510,) of which the following is a specification.

The present invention relates to electric-arc lamps, more particularly to that type of lamp known as "inclosed."

The invention has for its object to provide a lamp which is simple in construction and is cheap to manufacture.

The invention is shown in connection with a lamp designed for use on direct-current constant-potential circuits; but many of the features herein described are applicable to lamps designed for use on other circuits.

In the accompanying drawings, which illustrate my invention, Figure 1 is a side elevation of a lamp with certain of the parts in section. Fig. 2 is a vertical section of the lamp. Figs. 3 and 4 are respectively a plan and side elevation of the resistance-support frame. Fig. 5 is a section taken on line 5 5 of Fig. 3. Fig. 6 is a section taken on line 6 6 of Fig. 3. Figs. 7, 8, and 9 are detail views of the lower-carbon holder or support. Fig. 10 is a sectional view taken on line 10 10 of Fig. 2 viewed in the direction of the arrow. Fig. 11 is a detail view of the upper-carbon holder, and Figs. 12 and 13 are further detail views of the carbon-holder.

Referring to Figs. 1 and 2, A represents the central tube, to which various parts of the lamp are secured. This tube is slotted at A' to permit the screw-head or some similar projection B on the upper-brush holder to move up and down and at the same time to prevent the brush-holder from twisting. Surrounding the upper end of the split central tube is a solenoid or magnet C. This magnet is provided with a spool having an enlarged head C', which is screw-threaded to the central tube A. The head is provided with lugs C<sup>2</sup>, and fastened to the lugs is a plate D, which carries the positive and negative binding-posts E and F. In the center of the plate D is a support G for suspending the lamps. The lower portion of the spool C is

provided with a cast-metal head C<sup>3</sup>, and extending downwardly from this head are three lugs C<sup>4</sup>. Mounted in each one of these lugs is an adjusting-screw C<sup>5</sup>, Figs. 2 and 10, which are employed to center the tube and spool with respect to each other. This centering or adjusting may be for the purpose of placing the parts in suitable alinement or it may be for the purpose of adjusting the magnetic relation of the parts.

Located in the space between the spool of the magnet C and the central tube A and mounted for movement therein is an armature H, made of magnetic material. On the lower end of the armature is plate H', which is provided with an extension H<sup>2</sup>, that is connected to the cylinder of a dash-pot. It is also provided with projections H<sup>3</sup>, located on opposite sides of the center, each projection having a hole for receiving a rod I, the latter being connected to the clutch J. The screws C<sup>5</sup>, in addition to centering the tube, are employed to act as a lower stop for the moving armature H. Near the lower end of the central tube A and secured thereto by a screw-thread is a disk K, which forms a part of the frame. Screw-threaded to this disk and extended upward is a pin L, that carries the piston L' of the dash-pot. The dash-pot is provided with a suitable metallic cylinder, with any suitable form of outwardly-opening valve located in the upper end. The piston consists of a central metallic stud, and surrounding it is a cylinder L<sup>2</sup>, of graphite, which is retained in place by a plate or washer L<sup>3</sup>, the upper end of the central stud being expanded to hold the same in place.

Extending downwardly from the disk K are two vertically-extending supports, which carry a second disk K', and this plate is provided with a central opening, through which the upper carbon extends. Mounted on the disk K' and suitably insulated therefrom is a binding-post K<sup>2</sup>. The screw which retains this binding-post in place passes through the disk K' and assists in securing the gas-cap M in place. The periphery of the gas-cap M is provided with a screw-thread, and engaging therewith is a screw-threaded ring M', which supports the arc-inclosing globe N.

The clutch for feeding the upper carbon

is provided with three pivoted clutch-shoes, which engage directly with the carbon. These shoes are pivoted at their inner ends to a plate J' and at their outer ends to links J<sup>2</sup>, which in turn are pivoted to the ring J<sup>3</sup>. The ring J<sup>3</sup> is provided with a central opening, which makes an easy-working fit with the central tube, the latter acting as a guide for the ring in its vertical movements. As the armature H moves vertically, it controls the action of the clutch through the rods I, either raising or lowering it, as the case may be. The disk K' is provided with a hub or extension, which surrounds the carbon, and as the clutch-ring J' descends it engages with this hub and causes the clutch to release the upper carbon. With good smooth carbon the feeding of the upper carbon is usually so slight as to be practically imperceptible, although at times the carbon will feed a considerable amount, in which case the coil C, acting on the armature H, will restore the arc to its proper length. In Fig. 1 the carbons are shown in contact with the circuit interrupted, while in Fig. 2 the parts are shown in the position occupied when the lamp is burning.

Referring to Figs. 3 to 6, inclusive, D represents the top plate of the lamp, having radially-projecting arms D', to which are secured the vertically-extending pieces P, that form supports for the steadying resistance Q. The pieces P, Figs. 5 and 6, are provided with reduced portions P<sup>2</sup> at the ends, whereby they may be riveted to the upper plate D and to the ring R. Midway between the extremities of the resistance-support piece P is an extension P', which serves to hold the insulators Q', which surround the resistance-wire and hold it in place. In the drawings five of these resistance-support pieces are shown; but the number may be varied as desired.

The lower-carbon holder is supported by two side rods S, which are screw-threaded to the gas-cap M. The lower extremity of each of these side rods is reduced in section and is screw-threaded to receive a nut for retaining the yoke S' in place. The yoke is provided with a U-shaped opening, as shown in Fig. 9, for receiving the carbon, and pivoted to a pin or projection S<sup>4</sup> on said yoke and extending around the carbon is an L-shaped clamp S<sup>2</sup>. This clamp is adjusted by the screw S<sup>3</sup>, which passes through the yoke, and by removing the screw the clamp may be removed from the lamp. On the lower side of the clamp is an intumed projection or stop S<sup>5</sup>, which is arranged to extend under the lower carbon and prevent it from dropping.

Referring to Figs. 11, 12, and 13, the construction of the upper-carbon holder will be described. In connection with arc-lamps of the type commonly known as "carbon-feed" it has been found desirable to provide some form of continuous connection between a stationary portion of the lamp and the moving carbon-holder in order that the circuit shall

be continuously maintained. To accomplish this, a cap T, having spring-arms, is provided, which is arranged to be forced up into and seated in the end of the central tube A, as shown in Fig. 2. To this cap is secured a flexible cable T', which is given a considerable number of turns, so that it will not interfere with the vertical movements of the upper carbon, and consequently hamper the feeding of the lamp. The upper-carbon holder proper consists of a sleeve T<sup>2</sup>, which is provided at its lower end with spring-fingers that clamp the upper carbon in place. Mounted within this sleeve is a weight T<sup>3</sup>, having a central opening to receive the cable T', the said opening being flared outwardly to prevent chafing or cutting of the cable. The lower end of the cable is secured by means of a screw, and the carbon-holder is prevented from turning within the central tube A by means of the screw B. In assembling the lamp the spring-cap T is forced into place in the upper end of the tube and the holder is inserted in place through the lower end of the tube, after which it is given the requisite number of turns and the screw B mounted in place. This screw prevents the turning of the carbon-holder and the proper relation of the parts is always maintained.

Referring more particularly to Fig. 1, special means have been provided for preventing the heat from the resistance affecting the regulating-coil C. To accomplish this, a cylindrical casing U is provided, having perforations in the lower part, which may or may not be arranged to form a design. This casing projects upward slightly above the coil and is placed midway between the coil and the resistance-wire, so that a ventilated space U' is provided all around the coil, and a space is also provided between the resistance-wire and the casing. Surrounding the resistance-wire and secured to the casing U is a cornice U<sup>2</sup> of any appropriate design. The lower portion of this cornice is provided with openings, through which air is free to enter, as indicated by the arrows. Just above these openings the main casing is perforated at a number of points U<sup>3</sup>, and as the air passes from the openings of the cornice it divides, one portion passing to the right and up past the point of the resistance-wire, the other portion passing through the opening U<sup>3</sup> into the space U and up through the top of the lamp. In addition to this air enters the openings in the portion of the casing opposite the dash-pot and mingles with the air from the openings U<sup>3</sup>. Thus it will be seen that a substantial draft is provided from the lower to the upper part of the lamp, which carries away a large portion of the heat developed by the resistance, and that the actuating coil or magnet C is protected.

The lower portion of the casing is secured to a ring O, the latter being secured to the plate K, but insulated therefrom. On the lower end of the casing U is an outwardly-

flaring flange U<sup>4</sup>, which is provided with screws V for retaining the shade V' in place.

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

1. In an electric-arc lamp, the combination of a tube, a coil and a spool both of which surround the tube, and adjusting devices mounted on the spool for centering or adjusting the relation of the tube and the spool.

2. In an electric-arc lamp, the combination of a vertically-extending tube forming the central portion of the lamp, a coil and a spool surrounding the tube, lugs formed on the spool, and adjusting-screws mounted in the lugs for centering the tube.

3. In an electric-arc lamp, the combination of a coil, a spool therefor, a tube which is screw-threaded to one head of the spool, lugs extending downwardly from the other head of the spool, and adjusting-screws mounted in the lugs for centering the tube and spool with respect to each other.

4. In an electric-arc lamp, the combination of a central tube which forms the lamp-frame, a spool separated from the tube and having a winding thereon, a tubular armature mounted for movement between the tube and the spool and independent of both, a clutch suspended by the armature, and a dash-pot for checking violent movements.

5. In an electric-arc lamp, the combination of a central tube which forms the lamp-frame, a cylindrical armature surrounding the tube and arranged to move independent thereof, a plate carried by the armature, and having a projection to which an element of a dash-pot is secured, a clutch, rods which connect the plate with the clutch, and a tripping-platform for the clutch which is rigidly secured to the tube.

6. In a resistance-supporting device, the combination of a plate, a ring, metal pieces which are riveted to the plate and to the ring, and are provided with projections, and insulators mounted between the projections for supporting the resistance.

7. In a carbon-holder, for an arc-lamp, the combination of a pair of side rods, a yoke having a U-shaped opening which yoke holds the lower ends of the rods in place, a pin or projection on said yoke, a clamp having an opening into which the pin projects, and a screw which acts to hold the carbon and clamp in place.

8. In an electric-arc lamp, the combination of a central tube, a detachable contact-cap having a spring-pressed finger, which cap is capable of sliding through the tube and is ar-

ranged to be mounted therein, a holder for the carbon rod, and a flexible cable which connects the cap and the holder.

9. In an electric-arc lamp, the combination of a slotted central tube, a detachable cap capable of sliding through the tube and arranged to be seated therein, a holder for the carbon which is provided with a projection that works in the slot in the tube to prevent the holder from turning, and a coiled cable which connects the cap and the holder.

10. As an article of manufacture, a holder for carbons, comprising a cap having a spring-pressed portion adapted to engage with a conducting-tube in the lamp, which cap is capable of being inserted or withdrawn from the tube, a holder containing a weight, and a flexible cable which connects the cap and holder.

11. In an electric lamp, the combination of an actuating-magnet, a resistance which is separated therefrom by an air-space, and a detachable cylindrical inclosing casing which extends between the coil and resistance-wire and prevents the heated air from directly striking the magnet.

12. In an electric-arc lamp, the combination of an actuating-magnet, a resistance which is separated therefrom by an air-space, a detachable cylindrical inclosing casing which extends between the coil and resistance-wire and prevents the heated air from striking the magnet, and a ventilated cornice which incloses the resistance-wire and is secured to the detachable casing.

13. In an arc-lamp, the combination of a magnet, a resistance which is separated therefrom by an air-space, a detachable ventilated cylindrical casing which surrounds the coil and prevents the hot air from striking the magnet, and a ventilated cornice which surrounds the resistance and is secured to the casing below the resistance, the openings in the cornice and the casing being so arranged that the same air will freely circulate in both.

14. In an electric-arc lamp, the combination of a tubular conductor, a cap arranged to make frictional engagement with the interior of the tubular conductor and so constructed that it can be forced into the end of the conductor, a carbon-holder, and a flexible conductor connecting the cap with the carbon-holder.

In witness whereof I have hereunto set my hand this 14th day of July, A. D. 1900.

CHARLES E. HARTMAN.

Witnesses:

WM. D. POOL,  
JOHN A. MCMANUS.



J. J. WOOD.  
ELECTRIC ARC LAMP.

APPLICATION FILED MAR. 19, 1902.

NO MODEL.

4 SHEETS—SHEET 2.

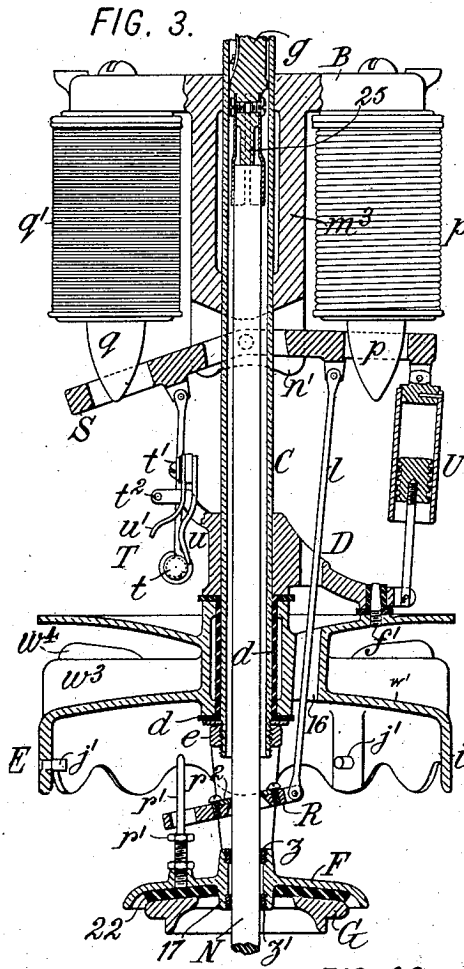


FIG. 8.

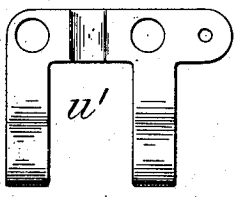


FIG. 9.



WITNESSES:  
*Reni Prune*  
*Fred White*

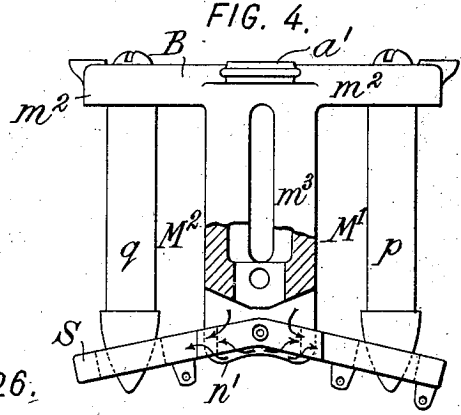


FIG. 26.

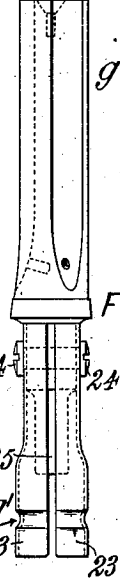


FIG. 19.

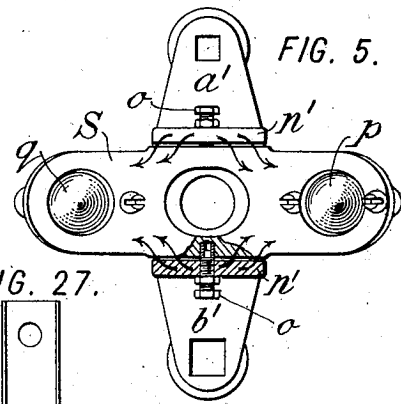


FIG. 27.

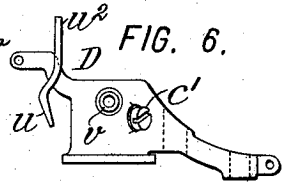
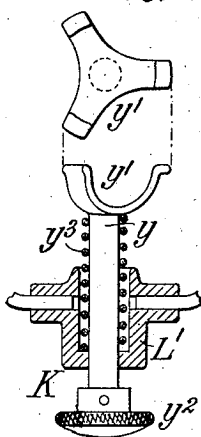


FIG. 6.

FIG. 7.



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ELECTRIC ARC LAMP.  
APPLICATION FILED MAR. 19, 1902.

NO MODEL.

4 SHEETS—SHEET 3.

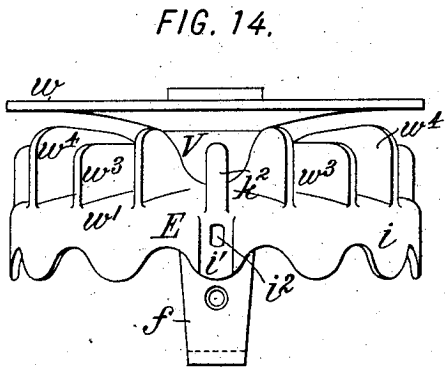
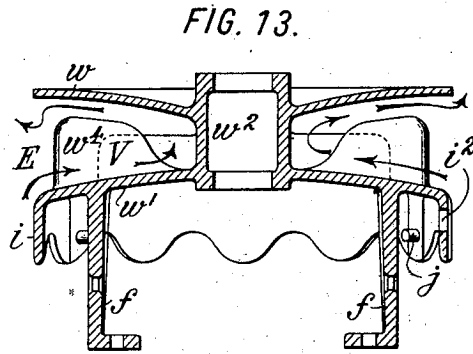
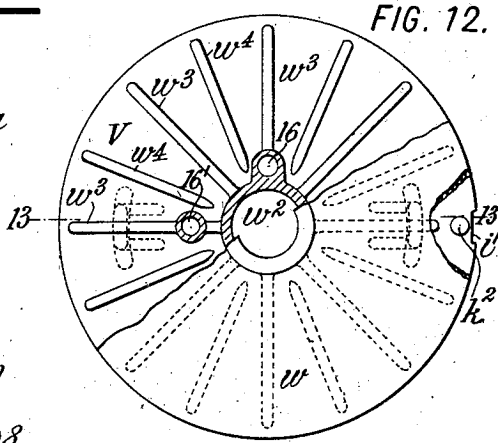
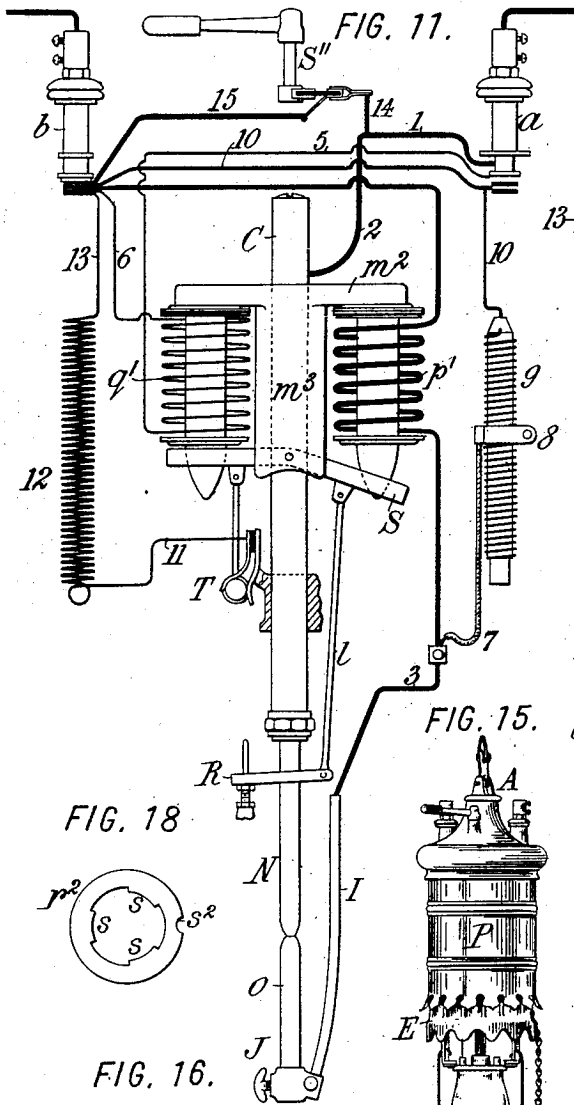


FIG. 18

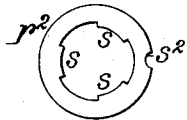


FIG. 16.

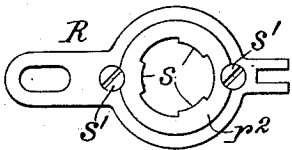


FIG. 17.

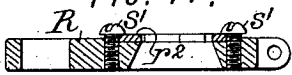
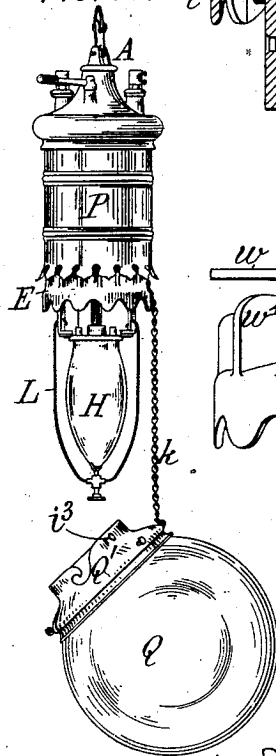


FIG. 15.



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ELECTRIC ARC LAMP.  
APPLICATION FILED MAR. 19, 1902.

NO MODEL.

4 SHEETS—SHEET 4.

FIG. 20.

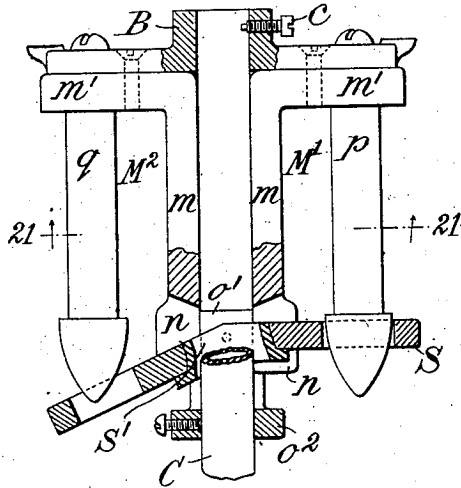


FIG. 23.

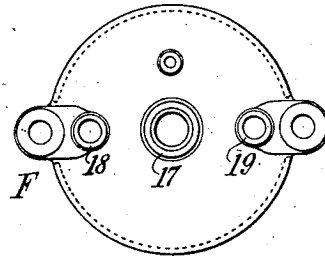


FIG. 24.

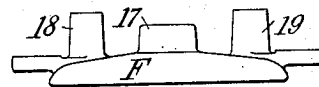


FIG. 21.

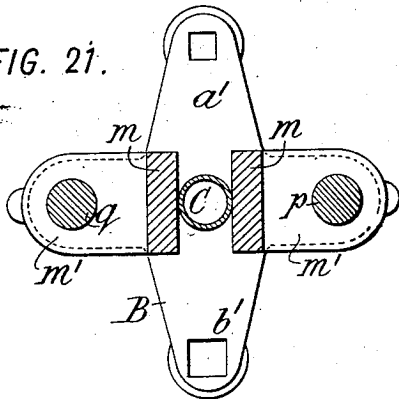


FIG. 25.

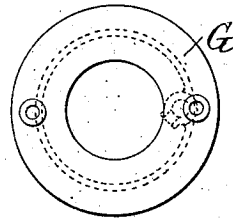
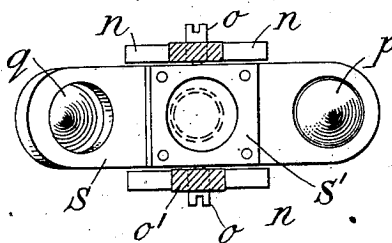


FIG. 22.



WITNESSES:

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*Fred White*

INVENTOR:

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*Ruthen C. Draser & Co.*

# UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF FORT WAYNE, INDIANA.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 724,366, dated March 31, 1903.

Application filed March 19, 1902. Serial No. 98,984. (No model.)

*To all whom it may concern:*

Be it known that I, JAMES J. WOOD, a citizen of the United States, residing at Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention provides certain improvements in electric-arc lamps designed chiefly for use on constant-current circuits, but adaptable also to other uses.

The invention relates in part to a differential regulating-magnet, in part to an improved automatic cut-out, in part to means especially applicable in an inclosed-arc lamp for preventing overheating of the mechanism, in part to an improved clutch, and also to various other features and details of construction.

The accompanying drawings show my improved lamp in its preferred form where my invention is embodied as an inclosed-arc carbon-feed lamp for use on constant-current series circuits.

Figures 1 and 2 are vertical mid-sections in planes at right angles to one another and showing the lamp inactive, the outer globe being omitted in Fig. 1. Fig. 3 is a section of the operative parts, on a larger scale, showing the lamp in operation, the mechanism-case being omitted. Fig. 4 is a sectional elevation of the magnet with its coils removed. Fig. 5 is an inverted plan thereof, partly in section. Fig. 6 is a side view, and Fig. 7 a plan, of a bracket which supports the cut-out and dash-pot. Fig. 8 is a front view (compare Fig. 1) of one of the cut-out terminals. Fig. 9 is a side and end view of the circuit-closing roller for the cut-out. Fig. 10 is a side view of the link which carries this roller. Fig. 11 is a circuit diagram. Fig. 12 is a plan of the heat-radiator, partly in section. Fig. 13 is a transverse section thereof cut on the lines 13 13 in Fig. 12. Fig. 14 is a side elevation thereof. Fig. 15 is an elevation of the entire lamp, on a small scale, with its outer globe lowered. Fig. 16 is a plan, and Fig. 17 a longitudinal section, of the carbon-clutch. Fig. 18 shows the clutch-ring removed. Fig. 19 is a sectional detail of the spring-holder for the inner globe. Figs. 20, 21, and 22 show a modified differential magnet. Figs. 23, 24, and 25 show the parts of

the gas-cap. Fig. 26 is an elevation of the carbon carrier and holder, Fig. 27 showing one of the springs thereof.

I will proceed to describe the construction of the lamp thus illustrated as embodying my invention.

In its mechanical construction the lamp comprises a hood A, adapted for suspension in the usual manner, beneath which is fastened, preferably by means of the binding-posts *a b*, Fig. 1, a plate or casting B, which supports (and may form part of) the core of the differential regulating-magnet M. Centrally within this plate B is fastened a vertical tube C, which affords the sole mechanical support for the parts beneath and through which travels the upper carbon. A bracket or casting D is fastened upon the tube C considerably below the magnet. The castings B and D are firmly fastened to the tube by screws or pins *c c'*, so that they are rigidly connected together through the tube. Upon the lower end of the tube, directly beneath the bracket D, is fastened another casting E, which I shall term a "heat-radiator." This is preferably insulated from the tube and from the bracket D by an intervening insulating-bushing *d*, Fig. 3, and is clamped in place by a nut *e*, screwing on the lower end of the tube. To keep it from turning on the tube, it is provided with a pin *f*, which projects up through the hole in an arm on the bracket D, Fig. 3, this pin being separated from the bracket by intervening insulation.

The radiator E supports beneath it a cross head or plate F, forming part of the gas-cap for closing the top of the inner globe H. The plate F preferably serves as the mechanical support for the arm I, which carries on its lower end the lower carbon-holder J. In the construction shown the arm I is connected directly and electrically to a gas-ring G, which is insulated from the cross-head F. The cross-head F is shown as supported by being clamped to the lower ends of pendent arms *ff*, Fig. 1, cast integrally with the radiator E. The inner globe H is supported by a spring-clamp K at its lower end, which clamp is hung on a swinging bail L, formed of wire rods, the upper ends of which are formed so as to hook into holes in the arms *ff*. (See Fig. 1.)



N and O are respectively the upper and lower carbons. The lower carbon is held in the holder J, as usual, while the upper one passes up into the tube C and is engaged at its upper end by any suitable kind of carrier or trolley *g*, (the trolley shown being of the general construction set forth in my Patent No. 678,607, granted July 16, 1901,) or may be connected in any other way to the appropriate circuit-terminal.

The lamp is provided with a cylindrical casing P, which incloses the space between the upper hood A and the lower casting or radiator E, which inclosed space constitutes the mechanism-case. The casing P is preferably of sheet metal and is preferably removable by being displaced downwardly, to admit of which the radiator-casting E is made of slightly-smaller external diameter than the internal diameter of the casing. The upper end of the casing projects up within the downturned flange of the hood A and is fastened in place by angular slots or bayonet-joints engaging pins *h* within this flange.

For supporting the outer globe Q its neck or upper flange is engaged in an annular hood or holder Q', preferably of sheet metal, the upper part of which is contracted to form a neck Q<sup>2</sup>, which projects up within a downwardly-projecting flange *i* on the radiator-casting E. To provide an easily-detachable connection, the neck Q<sup>2</sup> is formed with angular or bayonet slots *j*, engaging pins *j'*, projecting inwardly from the flange *i*. To disconnect the outer globe, it is only necessary to lift and slightly turn the globe and its holder Q', whereupon they may be lowered until they hang suspended by a chain *k*, as shown in Fig. 15. The casing P may then be similarly disconnected and lowered. The globe Q is attached to the holder Q' in any known way—as, for example, by set-screws, of which one is shown at W in Fig. 2.

These several features of mechanical construction, to which, however, my invention is not limited, being now understood, I will proceed to describe those features of my invention which constitute its most important and essential portions.

The carbon-clutch R, which is located beneath the radiator E, is connected in a simple manner by a single link or connecting-rod *l* directly to the armature S of the regulating-magnet M. The regulating-magnet is of novel construction. It involves, essentially, two magnets or magnetic circuits, which may be wholly distinct or may have one core or frame in common, the respective magnets or magnetic circuits being excited by series and shunt coils to attract differentially the opposite arms of a tilting lever constituting or formed with the armature or armatures of the respective magnets. This armature-lever or lever-armature is pivoted intermediate of its ends, so that its respective end portions are arranged in proximity to the pole-pieces of the cores or portions of the magnetic system

which are wound with the respective coils, and its intermediate portion is so connected magnetically as to complete the two magnetic circuits which include the respective cores within the coils and the respective arms of the armature or armature-lever. The magnetic connection is so made as to distribute the magnetic flux from the fixed magnet to the armature in such manner that the middle or pivotal portion of the latter shall be approximately in magnetic equilibrium. To this end the magnetic flux is directed laterally into the pivotal portion of the armature, both from above and from beneath, so as to avoid any preponderance of attraction in one direction such as would force the armature strongly against its pivots, and thereby cause friction. By my construction I reduce the upward attraction substantially to that occurring at the varying air-gap between the pole-pieces and the outer portions of the armature, and this upward attraction is so graduated to the weight of the armature that under normal conditions it approximately equals the weight. It results from this that the armature is very sensitively hung, the upward magnetic attraction being approximately balanced by the downward force of gravity, so that the armature is free to respond with great sensitiveness to any relative variations of attraction in the respective magnet-cores due to variations of excitation of their respective coils. The armature may thus with substantial accuracy be denominated a "floating armature," since it rests in substantial equilibrium between the upward attraction of the magnetic force and the downward attraction of gravity.

The composite or differential regulating-magnet may be constructed of two distinct magnets, as shown in Figs. 20, 21, and 22, or it may be constructed with a single magnetic frame, as shown in Figs. 1 to 5 and Fig. 11. As the essential construction is most clearly apparent from Figs. 20 to 22, I will first describe the form there shown. The four-armed plate B here forms no necessary part of the magnetic system, except to support the same, and may be of brass. Its arms *a' b'* are attached to the respective binding-posts, while its two other arms overlies the respective magnet-frames and are fastened to them to support the composite magnet. This is composed of two U-shaped or horseshoe magnets or magnet-frames M<sup>1</sup> and M<sup>2</sup>, one of which consists of a core *p*, wound with a series coil *p'*, and of an L-shaped plate, of which the base *m'* is fastened to the supporting-plate B, while the downwardly-projecting portion *m* extends parallel with the core *p* outside of the coil and at its bottom portion is widened and cut out centrally to form ears *n n*, which extend down on opposite sides of the armature. The other or shunt magnet frame M<sup>2</sup> consists of a core *q*, wound with a shunt-coil *q'*, and a similar L-shaped frame, comprising an upper base *m'* and dependent arm *m*, di-

vided in like manner at its lower part to form ears  $n n$ . The armature or armature-lever S is shown as composed of two iron armatures, one for each of the magnets, united by a middle portion S', of non-magnetic material, such as brass, which is formed with a central hole for the passage of the tube C and is pivoted between opposite pivot-screws  $o o$ , engaging it at a point between the legs  $m m$  of the respective magnets. The iron arms are shown as perforated to receive the lower ends or pole-pieces of the cores  $p q$ , which are tapered or conoidal and enter more or less within the holes, according to the varying positions of the armature. The pivot-screws  $o o$  may be supported in any suitable way—as, for example, by means of upwardly-projecting ears  $o'$  on a collar  $o^2$ , preferably of brass, fastened by a set-screw on the central tube C. By this construction the fixed parts or frames of the respective magnets are rendered wholly distinct, while the respective iron armatures, being separated by the brass piece S', are also kept distinct, so that the two magnetic circuits instituted by the exciting-coils  $p' q'$  are maintained entirely separate and distinct from one another. The two distinct magnets M' and M<sup>2</sup> constitute, in effect, one differential magnet, in that the armatures are so mechanically connected as to be forced to move together as a single armature-lever or lever-armature. They might be made integral as a single armature like that shown in Figs. 4 and 5 to similar effect. According to the other construction of magnet (shown in Figs. 4 and 5) the individual magnets M' and M<sup>2</sup> are to some extent merged together by having one common core or frame. This construction is electrically substantially like that already described, but mechanically is somewhat preferable, as it simplifies the construction of the lamp. Referring to Figs. 4 and 5, the top or base plate B is here integral with the magnetizable frame of the combined magnet, and hence is made of iron. The plate B has four arms, of which  $a' b'$ , as before, are pierced with square holes to receive the binding-posts, while the other two arms  $m^2$  form the yoke for connection between the soft-iron cores  $p q$  of the magnet and an intermediate third leg or projection  $m^3$ , which projects downwardly between the cores  $p q$ . This third leg, which takes the place of the vertical portions  $m m$  of the magnet-frames in Fig. 2, serves in this construction several purposes. One function is, as before, to form the magnetic connection between the upper ends of the cores  $p q$  and the armature S. The second function is to form the pivotal support for the armature, for which purpose this leg is made with ears  $n' n'$ , which ears embrace the pivoted portion of the armature freely between them and receive the pivot-screws  $o o$ , Fig. 5, the ends of which enter bushed holes in the armature. A third function of the middle leg  $m^3$  is to constitute the mechanical connection for upholding the cen-

tral tube C of the lamp, for which purpose the leg is made tubular, Fig. 3, the tube C being fastened within it by set-screws  $c c$ , Fig. 1. The cores  $p q$ , inclosed within the series coil  $p'$  and shunt-coil  $q'$ , respectively, have projecting tapered or conoidal ends entering holes in the respective arms of the armature, which latter is made in one piece of iron. This construction of pole-pieces and armature has the effect of reducing the air-gap and magnetic resistance and in connection with the floating of the armature magnetically, as described, produces a very sensitive differential magnet. The middle leg  $m^3$  is cut away obliquely above the pivotal portion of the armature, as shown in Fig. 4, in order to concentrate the magnetic flux at the sides of the armature and reduce to the minimum any flux entering the armature from above. It may thus be cut away above the armature to greater or less extent in order to give the armature the desired equilibrium. It is important that practically all the magnetic lines of force shall enter the armature at the sides through the ears  $n'$  rather than at the top in order to avoid attracting the armature to an extent materially in excess of that which will balance its own weight. In practice and with the proportions shown the adjustment is such that the upward pull, due to magnetism, but slightly exceeds the downward pull, due to the weight of the armature and its dependent parts. Consequently the armature hangs in approximate equilibrium, whereby it responds with great sensitiveness to the differential attraction of the respective magnet-cores  $p q$ .

The circuit connections are preferably made as indicated in the circuit diagram Fig. 11. The main current entering at the positive binding-post  $a$  passes through the plate B to the central tube C, (this connection being indicated by the lines 1 2 in Fig. 11,) thence through the tube C to the trolley  $g$ , thence through the positive and negative carbons N and O, thence through supporting-arm I, gas-cap G, and connecting-wire 3 to the series coil  $p'$ , thence by wire 4 to the negative binding-post  $b$ . The shunt-current passes through binding-post  $a$  by wire 5 to the shunt-coil  $q'$ , thence by wire 6 to the binding-post  $b$ . For adjusting the strength of the series side of the magnet I provide a shunt short-circuiting the series coil  $p'$  through an adjustable resistance, this shunt following the wire 7, clamp 8, and more or less of the adjusting resistance-coil 9 and thence through wires 10 to the binding-post  $b$ . The relighting-shunt extends from the tube C through the contacts of the relighting cut-out T, (to be described later,) and thence by wire 11, resistance-coil 12, and wire 13 to the binding-post  $b$ . A short-circuiting switch S'' is provided, as usual, for making direct connection between the binding-posts, as indicated in Fig. 11, by the wires 1 14, leading to one terminal of the switch; and the wire

15, leading from the other terminal to the binding-post *b*.

The operation in general is the same as that of previous series arc-lamps governed by a differential magnet. The condition before turning on the current is indicated in Fig. 2. On establishing the current the series coil *p'* energizes the side of the magnet comprising the core *p* and attracts the corresponding arm of the armature, which arm being connected by the link *l* to the clutch *R* lifts the latter, which tilting engages and lifts the upper carbon, as shown in Fig. 5. The same movement breaks the circuit through the relighting resistance *9*. The drawing of the arc introduces a resistance into the main circuit, whereby a proportionate amount of current is diverted through the shunt-coil *q'*, and as the arc burns longer the current thus diverted increases, and the attraction of the core *q* gradually increases relatively to that of the core *p*, so that the armature gradually tilts and lowers the clutch *R* and the carbon until the clutch releases and permits the carbon to feed through it, again tilting and gripping it as soon as the attraction of the series coil *p'* preponderates over that of the shunt-coil *q'*. By reason of the sensitiveness of the regulating-magnet the movements of its armature perfectly obey the differential attraction of the magnet. The magnet may be wound with any known combination of series and shunt coils.

The movements of the armature are moderated by a dash-pot *U* or other retarding device of any usual kind. This is most advantageously connected between the extreme end of the series arm of the armature and the end of the arm of the bracket *D* beyond where this arm is engaged by the pin *f'*.

The clutch *R*, as shown, consists of an arm having a central hole through which the carbon passes, said arm being connected at one end to the link *l* and having at its other end a slot which is engaged by a guide-pin *r*, having a flange *r'* forming the stop for the clutch, and which pin is adjustable up or down in order to vary the height of this stop. The pin is conveniently mounted upon the gas-cap plate *F*, which has a threaded boss into which the screw-threaded shank of the pin screws, a lock-nut being provided to hold the pin at any adjustment. The clutch-arm is provided with a ring *r<sup>2</sup>*, (shown separately in Fig. 18,) which immediately engages the carbon, this ring being cut away interiorly except at three points *s*, which alone engage the carbon, so that the carbon instead of being clamped at two diametrically opposite points, as with an ordinary ring, is clamped at three approximately equidistant points, which results in a free and smooth feeding movement. The ring is fastened to the clutch-arm *R* by two screws *s' s'*, one of which engages a notch *s<sup>2</sup>*, Fig. 18, in the ring for correctly locating the ring relatively to the arm.

The relighting cut-out *T* is of novel con-

struction. It comprises a movable conducting-piece, as a cross-bar or roller, so connected to the armature that when the armature is attracted abnormally to the shunt-coil side of the magnet it draws the cross-bar into a converging space between the cut-out terminals, and thereby closes the circuit through the cut-out resistance-shunt. The cross-bar *t* is preferably formed as a roller, Fig. 9, and hung by a link *l'*, Fig. 10, from the armature on the shunt-coil side of its pivot. The link *l'* is formed at its lower end with an eye which loosely embraces a groove in the roller *t*, leaving the latter free to turn. The cut-out terminals are lettered *u* and *u'*, respectively. Preferably the terminal *u* is supported on the bracket *D* by being formed integrally therewith, although it might be otherwise supported. By this construction it is connected through the bracket *D* to the central tube *C* and thence to the positive binding-post *a*. The opposite terminal *u'* is arranged adjacent to the terminal *u*, but insulated therefrom, and is connected to the resistance *12* and thence to the negative binding-post *b*. The terminal *u'* is shown as of sheet metal, Fig. 8, and fastened against a plate *u<sup>2</sup>* on the bracket *D* by means of an insulating-fastening. The arrangement is such that gravity keeps the roller *t* in approximate contact with the terminal *u*, and during its upward movement from the position shown in Fig. 3 to that shown in Fig. 2 it enters beneath the yielding arms or fingers of the terminal *u'* and forms a conducting-bridge between the respective terminals. The respective terminals converge slightly, their faces forming an acute angle, so that the upward movement firmly wedges the roller *t* in between them. At each movement the roller *t* turns a little, whereby it continually presents a fresh surface, and its frictional contact with the terminals keeps its surfaces clean. The roller *t* is kept from any accidental displacement such as might cause it to fail to enter properly between the terminals by means of a pin *t<sup>2</sup>*, closing a guiding-notch *t<sup>3</sup>*, formed in an arm on the bracket *D*, in which notch the link *l'* is engaged. To get access to the contacting surfaces it is only necessary to withdraw the pin *t<sup>2</sup>*, whereupon the roller *t* can be swung outward and the surfaces of the terminals *u u'* can be examined and cleaned.

The bracket *D*, which is shown separately in Figs. 6 and 7, has several important functions. By being fastened on the tube *C* it serves as an abutment against which to clamp the radiator *E*. Its projecting arm serves as a support for the dash-pot *U*. The same arm by receiving the pin *f'* serves to prevent rotary displacement of the radiator. On its opposite side the bracket carries the cut-out terminal *u* and opposite terminal *u'* and is formed with the guiding-slot *t<sup>3</sup>* for the link *l'*. In addition the bracket is formed with two oppositely-projecting arms *v v'*, Fig. 7, which arms, as shown in Fig. 1, serve as the

supports, respectively, for the lower ends of the relighting resistance-coil 12 and the adjusting resistance-coil 9, the upper ends of these coils being mechanically connected to the respective binding-posts, although the coil 9 is insulated from the binding-post *a*.

The radiator E will now be described. In lamps of the character shown, wherein to secure compactness the arc (usually an inclosed arc) is arranged as close as possible beneath the mechanism-case, much difficulty has been experienced by reason of the upward transmission of heat from the arc to the mechanism within this case. The object of this feature of my invention is to remedy this difficulty by effecting a radiation of heat between the arc and the interior of the mechanism-case. Such radiation is the function of the radiator E. This radiator comprises two approximately horizontal plates *w* and *w'*, which may or may not be connected in one casting through an intervening neck or hub *w*<sup>2</sup>, Fig. 13. The plates *w w'* are somewhat widely separated to form between them an air-space or radiating-chamber V. The plate *w* serves to close the bottom of the mechanism-case, while the plate *w'* serves as a top plate or roof for the chamber inclosed within the outer globe Q. (See Fig. 2.) The highly-heated air or gases in this chamber rising to the top thereof communicate their heat to the plate *w'*, which in turn radiates it into the air-chamber V between the plates. This air-chamber V is open to the outer air on all sides beneath the lower end of the casing P, so that air may freely circulate through this chamber from all sides. In case the wind is blowing the circulation will naturally be in a direction approximately diametrically across the chamber. In still air a draft will be occasioned by the heat in the manner indicated approximately by the arrows in Fig. 13. If the plates *w w'* alone were used, the surface of the latter plate would be insufficient for the effective radiation of heat to the air, and hence I increase this surface by forming the plate *w'* with flanges or ribs projecting perpendicularly from it into the air-chamber V. These flanges or ribs are lettered *w*<sup>3</sup> *w*<sup>4</sup> and are shown as projecting radially in vertical planes, so as to leave between them radial channels for circulation of air. As shown, the alternate plates *w*<sup>3</sup> are straight on their upper edges, Fig. 3, and of less projection than the intervening plates *w*<sup>4</sup>, which latter are cut away toward the middle, as shown in Fig. 13, to avoid choking the air-channels. This special construction and arrangement of the plates or flanges, however, is not essential, as any arrangement of upwardly-projecting plates, flanges, or other projections adapted to increase the radiating-surface, and thereby augment the rate of conduction of heat from the radiator to the air, will be within my invention. The upper plate *w*, if made integral with the lower plate, is preferably

connected to it only through the hub *w*<sup>2</sup> in order to avoid as far as possible direct conduction of heat into the mechanism-case. The radiator is shown as provided with an opening 16, Fig. 3, for the passage of the link *l* (the bracket D also having a similar opening) and with also an opening 16' for the passage of the conducting-wire 3, Fig. 1. The lower plate *w'* of the radiator slopes from the center outward in order to shed any rain that may drive in, and at its outer edge is extended downward to form the flange or rim *i*, before described, so that this rim serves to shed rain onto the exterior of the globe-holder Q', which in turn sheds it over the outer globe.

When the globe-holder Q' is disconnected from the lamp-body and the globe lowered, so as to hang by the chain, as shown in Fig. 15, it is often desirable to be able to readily disconnect the chain, so as to wholly sever the globe-holder from the lamp-body. To this end I provide the upper end of the chain *k* with an eye *k'*, (shown in elevation at the right of Fig. 1,) and I provide a suitable pin or stud *k*<sup>2</sup> upon some convenient part of the lamp-body, over which pin or stud the eye *k'* may be dropped, so that it will hang in place normally by its weight, but so that when it is desired to disconnect it it is only necessary to lift it sufficiently to free it from the pin or stud. I preferably form the pin or stud *k*<sup>2</sup> as an integral part of the radiator E, as shown in Fig. 1 and in plan in Fig. 12. Beneath the pin *k*<sup>2</sup> the flange *i* is provided with a slight recess or vertical groove *i'*, Fig. 12, in which the eye *k'* may lie.

To prevent accidental disengagement of the outer-globe holder Q', I provide a catch or latch engaging its neck and adapted either to prevent its turning or to prevent its lifting. By preventing either of these movements the disengagement of its bayonet-notches from the pins *j'*, projecting within the pendent flange *i*, is prevented. The catch is preferably a gravity-catch, and for convenience of manipulation it is preferable to have some connection with the catch that is easily found and grasped in order that by moving this connection the catch may be withdrawn. These several requisites I preferably and most simply supply by providing the eye *k'* with a lateral projection *k*<sup>3</sup>, Fig. 1, adapted to project through a hole *i*<sup>2</sup> in the pendent flange *i* (best shown in Fig. 14) and into a corresponding hole or notch *i*<sup>3</sup>, Fig. 15, in the neck of the globe-holder Q', as clearly shown in Fig. 1. As the eye *k'* hangs from its upper end, its weight causes it to keep the projection *k*<sup>3</sup> in place until the operator to disengage the catch pulls upon the chain *k*. Thus the eye serves the double purpose of a suspension for the chain and a catch for locking the globe-holder, while the chain serves as a handle for this catch. By making the hole *i*<sup>3</sup> sufficiently small the projection *k*<sup>3</sup>, entering it, serves to prevent both the lifting and the turning of

the globe-holder; but any engagement that will prevent either of these movements will suffice.

The inner-globe holder K is necessarily a yielding or spring holder for pressing the globe upwardly into firm contact with the gas-cap G. I construct it, as shown in Fig. 19, with an upright plunger or rod *y*, having free vertical play in a socket-piece L', carried at the bottom of the bail L, formed at its upper end with three (more or less) arms or fingers *y'* for engaging the globe and formed at its lower end with a head *y*<sup>2</sup>. It is pressed upwardly by a spiral spring *y*<sup>3</sup>, which reacts against and seats within the socket-piece L'. To release the globe, it is only necessary to pull down the rod *y* and then swing the bail L to one side. This construction of globe-holder is not herein claimed, being made the subject of a separate application filed March 9, 1903, Serial No. 146,944.

The construction of the gas-cap for the inner globe presents some novel features. Instead of being of one plate only it is built up of two parts F and G. The part G, which alone touches the inner globe, is a ring separated from the mechanism-case or radiator E by two insulations. It is supported upon but insulated from the cross bar or plate F, while this plate is supported by but insulated from the bottom plate of the radiator E. The construction of the upright arms *f*, integral with the radiator, is advantageous in bringing the insulated connection down to where it is readily accessible and avoids forming holes through the radiator or into the mechanism-case for making this connection. The plate F, which is shown separately in plan in Fig. 23 and in elevation in Fig. 24, is formed with a central neck 17 and with two upwardly-projecting necks 18 19 on opposite sides thereof. The central neck 17 is that through which the upper carbon N passes. The necks 18 19 serve for the attachment of the gas-ring G, and one of them serves also for making electrical connection with the lower or negative carbon holder. As shown, screws 20 and 21 pass through insulating-bushings in the necks 18 19 and engage the gas-ring G. One of these, 20, has at its upper end a coupling for uniting to it the conducting wire or rod 3, which passes up through the radiator into the mechanism-case. Upon unscrewing this coupling the electric connection may be severed for disconnecting the gas-ring. The gas-ring G serves as a conducting connection between the wire 3 and the arm I, supporting the carbon-holder J, the upper end of this arm I being fastened in a socket in the gas-ring. By extending the necks 18 19 upwardly the insulated screw connection is lifted to where there is no possibility of the insulation being bridged by accumulations of carbon-dust. In this preferred construction the gas-cap is, in fact, composed of the central part of the plate F, together with the annular part G. The latter (shown in plan in Fig. 25) is rabbeted to re-

ceive the upper end of the globe H. It is insulated from the plate F by the insulation 22, which latter is perforated centrally to enable the central neck 17 on the plate F to project downwardly within the annular part G of the gas-cap.

The neck 17 of the gas-cap is of novel construction, applicable whether the gas-cap as a whole is made of two parts F G or of one part. It is desirable that the opening through which the carbon passes shall be as small as possible in order to prevent access of air. The gas-cap is commonly made of iron to withstand the heat, and much difficulty has been experienced by reason of the cap rusting and causing the carbon to stick. This I overcome by forming the neck 17 of the gas-cap of a diameter considerably larger than that of the carbon, so as to leave a free space between, as best shown in Fig. 3, and providing the neck with one or more bushings of a suitable refractory and non-oxidizable metal, making as close a fit with the carbons as is practicable. I prefer two bushings *z z'*, located as shown in Fig. 3, at the top and bottom of the neck, so as to leave a confined space between them. I prefer to form these bushings of copper, as this is the most refractory and least oxidizable metal available at a cost which is not prohibitory. By these means the difficulties heretofore encountered are obviated.

The carbon carrier or trolley *g*, which slides freely in the tube C, has a carbon-holder *g'* at its lower end for engaging the carbon N and has at its upper part contact-springs pressing lightly outward to make electrical connection with the tube C, these springs being of the construction shown in my said Patent No. 678,607. The carbon-holder *g'*, however, is of novel construction. It is formed, as shown in Fig. 26, of two jaws 23 23', of elastic sheet metal, each pressed or struck up in a die to the form shown in Figs. 26 and 27, the lower part of the two springs being expanded to a diameter slightly smaller than that of the carbon, so as to cling upon the latter when it is thrust up within them, while the upper part or neck of the spring-jaws is contracted to a smaller diameter to fit the contracted neck portion of the trolley, to which the jaws are fastened by screws 24 24 or other suitable means. From the neck of the trolley a central projection 25 is carried downward to serve as a stop to prevent the carbon being pushed too far up within the clamp. This form of clamp or carbon-holder grips the carbon firmly but yieldingly and makes a very perfect electrical contact therewith. The spring-jaws 23 are formed with indentations 23<sup>a</sup>, whereby the socket of the clamp or holder is locally contracted, so as to form a sort of rocking engagement with the carbon. These indentations are preferably formed as ribs or beads which extend circumferentially around the socket or holder; but they might be otherwise formed. By this conformation of the

holder the carbon is embraced or gripped locally at points about an approximately circumferential line. The purpose of this construction is to so engage the carbon as to permit of its being adjusted universally or in any direction in order to compensate for any crookedness of the carbon, and thereby enable the carbon as a whole to be correctly aligned with the carrier or, in other words, with the tube C, so that the lower part of the carbon can pass freely through the gas-cap. Thus with a carbon which is slightly crooked its tendency to bind in the gas-cap is entirely obviated.

I provide an insulating-suspender for the lamp, as shown in Figs. 1 and 2. The hood A has, as usual, perforated ears 26, between which an insulating spool or button 27 is supported on a cotter-pin 27'. This insulator 27 is embraced by a U-shaped link 28, Fig. 1, between the upper legs of which another insulator, 29, is confined on a cotter-pin 30, passing through perforations in the upper ends of the legs. Around this insulator 29 passes the suspension loop or link 31. The links 28 and 31 have, respectively, ears 32 and 33, shaped to cause any drip to fall outwardly instead of falling centrally beneath. Thus the lamp is suspended through a doubly-insulating suspension device.

It must not be inferred from the minuteness with which I have described the several details of construction of the preferred embodiment of my lamp which is shown in the drawings that my invention is by any means limited to these details. My invention is susceptible of various modifications in matters of mechanical construction and in the substitution of mechanical and electrical equivalents. For example, the series and shunt coils may be otherwise wound on the differential magnet according to any known or suitable method.

What I claim is—

1. A differential magnet and armature, the latter pivoted to rock as the relative strength of the magnet-poles varies, the magnet-poles and armature relatively shaped to distribute the magnetic flux symmetrically so that the armature is attracted in line with the poles and without imparting end thrust thereto, and the armature acted on by a force opposing and substantially equal to the normal attraction of the magnet, so that under normal excitation the armature floats in substantial equilibrium, whereby pressure against its pivotal surfaces is mainly avoided and a high degree of sensitiveness is attained.

2. A differential magnet and armature, the latter pivoted to rock as the relative strength of the magnet-poles varies, the magnet-poles and armature relatively shaped to distribute the magnetic flux symmetrically so that the armature is attracted in line with the poles and without imparting end thrust thereto, the magnet arranged with its poles projecting downward and the armature arranged be-

neath it so that the downward force of gravity shall oppose and substantially equalize the normal attraction of the magnet, so that under normal excitation the armature floats in substantial equilibrium, whereby pressure against its pivotal surfaces is mainly avoided, and a high degree of sensitiveness is attained.

3. In an arc-lamp, a differential magnet with downwardly-projecting legs, and an armature pivoted between their poles with its ends adjacent to their respective pole-pieces, the pole-pieces and armature being relatively conformed to react symmetrically, whereby the magnetic attraction is substantially in line with the poles, and the armature of such weight as to hang in substantial equilibrium between the normal upward attraction of said magnet and the downward force of gravity.

4. In an arc-lamp, a differential magnet comprising two cores, a series coil magnetizing the one, a shunt-coil magnetizing the other, a lever-armature pivoted between the pole-pieces of said cores with its opposite arms arranged beneath and adjacent to the respective pole-pieces and conformed thereto to react symmetrically therewith, and a magnetic connection between the middle portion of the armature and each of said cores, whereby two magnetic circuits are formed through the respective coils and through the respective arms of the armature, said armature being of such weight as to hang in substantial equilibrium between the normal upward attraction of said magnet and the downward force of gravity.

5. In an arc-lamp, a differential magnet comprising a magnet-frame having three downwardly-projecting legs, the outer ones wound respectively with shunt and series coils, and an armature pivoted to the intermediate leg, with its ends adjacent to the poles of said outer legs, the pole-pieces and armature being relatively conformed to react symmetrically, the armature being of such weight as to hang in substantial equilibrium between the normal upward attraction of said magnet and the downward force of gravity.

6. In an arc-lamp, a differential magnet comprising a magnet-frame having three downwardly-projecting legs, shunt and series coils magnetizing the two outer legs, the middle leg being central and substantially tubular, and the upper-carbon holder movable within said central leg.

7. In an arc-lamp a magnet-core having three legs, an armature pivoted at its middle part to the middle leg, with its ends adjacent to the outer legs, said middle leg extending beyond and parallel with the pivotal portion of said armature to distribute the magnetic flux thereto; a shunt-coil magnetizing one outer leg, and a series coil magnetizing the other outer leg.

8. In an arc-lamp a magnet-core having three legs, an armature pivoted at its middle

- part to the middle leg, with its ends adjacent to the outer legs, said middle leg having pivotal ears embracing and extended parallel with the pivotal portion of said armature to distribute the magnetic flux thereto, a shunt-coil magnetizing one outer leg, and a series coil magnetizing the other outer leg.
9. In an arc-lamp, a magnet-core having three legs, the outer legs wound with shunt and series coils respectively, and the middle leg projecting between them, and an armature pivoted to the middle leg, the latter reduced above and adjacent to the armature to diminish the upward attraction for the armature at its pivotal portion.
10. In an arc-lamp, a magnet-core having three downwardly-projecting legs, the outer legs wound with shunt and series coils respectively, and their ends projecting beyond the coils as conoidal pole-pieces, and an armature beneath said coils, pivoted to the middle leg and having holes in its end portions coinciding with and receiving said pole-pieces, and the armature of such weight as to hang in substantial equilibrium between the normal upward attraction of said magnet and the downward force of gravity.
11. In an arc-lamp, the combination of a top hood, a magnet-core having an upper base-plate attached beneath said hood, and a pendent central tube rigidly connected to and suspended from said base-plate and projecting downward.
12. In an arc-lamp, the combination of a suspension-hood, a magnet-core having an upper base-plate adapted for attachment to said hood, and downwardly-projecting legs, one of which is central, and the lower parts of the lamp attached to said central leg, whereby the magnet-core serves as the medium for mechanically uniting the upper and lower members of the lamp.
13. In an arc-lamp, a mechanism-case and its suspension-hood, a magnet-core having an upper base-plate attached to said hood, and a pendent tubular leg central to said case, combined with a central tube fixed within said leg and to which the lower members of the lamp are attached.
14. In an arc-lamp, the combination of a mechanism-case, its top hood, a magnet-core formed with an upper base-plate attached beneath said hood, and with a pendent tubular central leg, a central tube fixed within said leg, and projecting downward, and the bottom plate of the mechanism-case attached to said tube.
15. In an arc-lamp, the combination of a mechanism-case, its top hood, a magnet-core having an upper base-plate attached beneath said hood, with a central tube C passing through and fixed to said base-plate and projecting downward, a bracket D fixed on said tube, and the bottom plate of the mechanism-case attached to said tube beneath said bracket.
16. In an arc-lamp, the combination of a top hood, a magnet-core having an upper base-plate attached beneath said hood, with a central tube C passing through and fixed to said base-plate and projecting downward, a bracket D fixed on said tube, and the bottom plate of the mechanism-case attached to said tube and having a non-rotative connection with said bracket.
17. In an arc-lamp, the combination of a top hood, a magnet-core formed with an upper base-plate attached beneath said hood, a central tube C fixed to said plate and projecting downward, a bracket D fixed on said tube and having a laterally-projecting arm, the magnet-armature, and a dash-pot connected between said armature and said bracket-arm.
18. In an arc-lamp, a heat-radiator between the arc and the mechanism-case comprising a plate having heat-radiating projections.
19. In an arc-lamp, a radiator comprising two horizontal plates separating the mechanism-case from the globe inclosing the arc, with an intervening ventilating-space, and heat-radiating projections from the lower plate for promoting radiation.
20. In an arc-lamp, a radiator comprising two horizontal plates separating the mechanism-case from the globe inclosing the arc, with an intervening ventilating-space, and radial plates projecting into said space from the lower plate for promoting radiation.
21. In an arc-lamp, a heat-radiator between the arc and the mechanism-case, comprising two horizontal plates separated to form an intervening ventilating-space, and connected together by a central tube, the lower plate having heat-radiating projections entering said space.
22. In an arc-lamp, the combination with a central tube C, of a heat-radiator comprising two horizontal plates formed in one integral casting with a central hub, said hub fitting over and attached to said tube, and said plates spaced apart to form an intervening ventilating-space, the lower plate having radiating projections entering said space.
23. In an arc-lamp, the combination of a suspension-hood, a cylindrical casing entering at its upper end within the lower part of said hood, and a heat-radiator supported from said hood and comprising two horizontal plates separated to form a ventilating-space, the upper plate arranged adjacent to the lower edge of said casing and adapted to form the bottom plate of the mechanism-case, and the lower plate arranged beneath the lower edge of said casing, whereby to expose said ventilating-space to communication with the outer air, said lower plate sloping from the middle outwardly, and turned down at its outer periphery to form a pendent flange, combined with the outer-globe holder having a contracted neck fitting up within said flange.
24. In an arc-lamp, the combination of a suspension-hood, a cylindrical casing entering at its upper end within the lower part of

said hood, and a heat-radiator supported from said hood and comprising two horizontal plates separated to form a ventilating-space, the upper plate arranged adjacent to the lower edge of said casing and adapted to form the bottom plate of the mechanism-case, and the lower plate arranged beneath the lower edge of said casing, whereby to expose said ventilating-space to communication with the outer air, and both plates of smaller diameter than said casing, whereby to admit of the removal of the casing downwardly.

25. In an arc-lamp, the combination of a suspension-hood, a plate *w'* supported beneath said hood and having a pendent peripheral flange *i*, a cylindrical casing the upper end of which enters within the lower portion of the hood, said plate and flange of smaller diameter than the interior of said casing to permit downward removal of said casing, and a globe-holder having a contracted neck fitting up within said flange.

26. In an arc-lamp, a heat-radiator *E* formed with pendent integral arms *ff*, combined with a gas-cap attached to and insulated from said arms, and with means for holding the inner globe against said gas-cap.

27. In an arc-lamp, the combination of a suspension-hood, a central tube with its upper part connected to said hood, a plate *w'* fastened on the lower part of said tube, said plate having pendent arms *ff*, the gas-cap for the inner globe supported from said arms, and means for holding the inner globe up against said gas-cap.

28. In an arc-lamp, a cast plate forming the bottom of the mechanism-case having integral arms projecting beneath it, a swinging bail hung from said arms, and a clamp carried by said bail for holding the inner globe in place.

29. In an arc-lamp, the combination of a plate *w'* having pendent arms *ff*, a cross-head *F* attached to said arms, a gas-ring *G* fastened to and insulated from said cross-head, the lower-carbon holder *J* and its supporting-arm *I* fastened to said ring *G*.

30. In an arc-lamp, the combination of a cross-head *F*, means for supporting it beneath the lamp-body, a gas-ring *G* fastened beneath and insulated from said cross-head, the cross-head formed with upwardly-extending necks 18, 19, and screws passing through insulating-bushings in said necks for fastening said ring.

31. In an arc-lamp, the combination of a cross-head *F*, means for supporting it beneath the lamp-body, a gas-ring *G* fastened beneath and insulated from said cross-head, a fastening-screw for said ring passing through a bushed neck on said cross-head, a circuit-wire extending from the mechanism-case down to said cross-head and joined by a detachable coupling to said fastening-screw, the lower-carbon holder *J* and its supporting and conducting arm *I* fastened to said ring *G*.

32. In an arc-lamp, a plate *w'* insulated from the lamp-circuit and having pendent

arms *ff*, a gas-cap supported from said arms, a swinging bail *L* hung from said arms, and a spring-clamp carried by said bail for pressing the inner globe up against said gas-cap, whereby the insulation of said plate insulates said bail.

33. In an arc-lamp, a gas-cap for closing the top of the inner globe, having a neck through which the carbon feeds with its opening considerably larger than the carbon, and two bushings of refractory non-oxidizable metal in said neck making a close fit with the carbon and with a confined space between said bushings.

34. In an arc-lamp, a gas-cap comprising an upper plate *F* having a central neck through which the upper carbon may pass, a ring *G* fastened beneath said plate with intervening insulation, and the lower-carbon holder connected to said ring.

35. In an arc-lamp, a gas-cap comprising upper and lower plates fastened together with intervening insulation, the lower plate adapted to receive the upper margin of the arc-closing globe, the lower-carbon holder hung by a conducting-arm from said lower plate, and said upper plate having a central neck through which neck the upper carbon may pass.

36. In an arc-lamp, a feed-clutch for the carbon comprising an arm having a central hole, and a ring fastened to said arm and having its inner peripheral portion cut away intermittently, leaving arc-shaped concave faces which engage the carbon.

37. In an arc-lamp, a feed-clutch for the carbon comprising an arm having a central hole, and a ring fastened to said arm, said ring formed on one side with a notch, and one of the fastening-screws arranged to enter said notch to correctly locate the ring relatively to the arm.

38. In an arc-lamp, a clutch-ring for the carbon-feed having its inner peripheral portion cut away intermittently leaving internal projections *ss* with arc-shaped concave faces which alone engage the carbon.

39. In an arc-lamp, a cut-out comprising opposite circuit-terminals having converging surfaces, and a movable conducting-piece rotatively connected to the armature and adapted by an abnormal movement thereof beyond the feeding movement to be moved against said terminals to form a bridge between them, the faces of said terminals contacting with said piece being at an acute angle with one another, so that said movement wedges said piece between their faces and in so doing rotates it, to continually change the contacting surfaces.

40. In an arc-lamp, a cut-out comprising opposite circuit-terminals having converging surfaces, the one substantially rigid and the other elastic, and a movable conducting-piece loosely connected to the armature and adapted by an abnormal movement thereof beyond the feeding movement to be moved against



- said terminals to form a bridge between them, the faces of said terminals contacting with said piece being at an acute angle with one another, so that said movement wedges said piece between their faces.
41. In an arc-lamp, a cut-out comprising opposite circuit-terminals having converging surfaces, and a movable conducting-piece loosely connected to the armature and adapted by an abnormal movement thereof beyond the feeding movement to be moved against said terminals to form a bridge between them, the faces of said terminals contacting with said piece being at an acute angle with one another, and at varying angles relatively to the direction of movement of said conducting-piece, so that said movement wedges said piece between their faces and in so doing tends to rotate it.
42. In an arc-lamp, a cut-out comprising opposite circuit-terminals, a roller, and a rod rotatively engaging said roller and pivotally connected to the armature, whereby the roller is moved by the armature against and between said terminals and may yield laterally in entering between them.
43. In an arc-lamp, a cut-out comprising opposite circuit-terminals, a movable piece adapted to enter between said terminals, and a rod connecting said piece with the armature and adapted to swing outward independently of movement of the armature to expose the contacting surfaces of said terminals.
44. In an arc-lamp, a cut-out comprising opposite circuit-terminals, a movable piece adapted to enter between said terminals, a rod connecting said piece with the armature, and a stationary guide for said rod adapted normally to guide said piece against said terminals and adapted to be opened to disengage said rod and permit the piece to be swung out to expose the terminals.
45. In an arc-lamp, a central tube C and a bracket D fixed thereon, and a cut-out, said bracket supporting a circuit-terminal of said cut-out, a second terminal mounted adjacent thereto, and a loose piece connected to the armature and movable against said terminals.
46. In an arc-lamp, a central tube C, a bracket D, a relighting cut-out having its terminals supported by said bracket, and a resistance-coil in circuit with said cut-out, said bracket formed with a projecting arm to which one end of said coil is attached.
47. In an arc-lamp, the combination of a suspension-hood, binding-posts passing through said hood, a central tube supported from said hood, a bracket D fixed on said tube and having laterally-projecting arms terminating beneath said binding-posts, and resistance-coils mechanically connected at their upper ends to said binding-posts and at their lower ends to said arms.
48. In an arc-lamp, a carbon-carrier and carbon-holder, the latter comprising concave sheet-metal springs reduced at their upper parts to smaller diameter than at their lower portions, their upper parts attached to a reduced neck on said carrier, and their lower portions projecting below said carrier and forming a tubular socket adapted to yieldingly receive and embrace the carbon.
49. In an arc-lamp, a carbon-carrier having a reduced neck at its lower part, and a carbon-holder consisting of concave sheet-metal springs, their lower portions adapted to fit and yieldingly embrace the carbon, and their upper portions of smaller diameter fitting and fastened to said neck.
50. In an arc-lamp, a carbon-carrier and carbon-holder, the latter formed of concave springs with their lower portions projecting below the carrier and adapted to form a yielding socket for embracing the carbon, their upper portions fastened to said carrier, and said carrier formed with a downward projection within said holder adapted to limit the thrust of the carbon thereinto.
51. In an arc-lamp, a carbon carrier and holder, the latter comprising concave sheet-metal springs projecting below the carrier so that their projecting portion constitutes a tubular yielding socket for the carbon, and said springs formed with indentations contracting said socket to locally embrace the carbon and permit of universal adjustment of the latter to bring it into alinement with the carrier.
52. In an arc-lamp, a globe-holder Q' adapted to carry a globe beneath it, connected to the lamp-body by a suspension-chain *k*, the lamp-body above the globe formed with a bottom plate E having on its top an integral pin or stud *k*<sup>2</sup> engaged by the terminal eye *k*' of said chain, whereby the globe-holder may be readily disconnected from the lamp-body.
53. In an arc-lamp, a globe-holder Q' connected to the lamp-body by a suspension-chain *k*, the lamp-body formed with a casing P and bottom plate E, the latter extended below said casing and having a stud *k*<sup>2</sup> projecting up within said casing and adapted to engage the terminal eye *k*' of said chain.
54. In an arc-lamp, a lamp-body having a pendent flange at its bottom, combined with a globe-holder having a neck entering up within said flange, said flange and neck having interengaging fastening provisions adapted to engage or disengage by a movement of the neck within the flange, and an independent catch adapted to lock said neck and flange together to prevent the disengaging movement of the neck, whereby to disengage the globe-holder such catch must first be withdrawn.
55. In an arc-lamp, a lamp-body having a pendent flange at its bottom, combined with a globe-holder having a neck entering up within said flange, said flange and neck having interengaging fastening provisions adapted to engage or disengage by a movement of

the neck within the flange, and an independent catch adapted to lock said neck and flange together to prevent the disengaging movement of the neck, consisting of a projection adapted to enter through coinciding holes in said flange and neck.

56. In an arc-lamp, a lamp-body having a pendent flange at its bottom, combined with a globe-holder having a neck entering up within said flange, said flange and neck having interengaging fastening provisions adapted to engage or disengage by a movement of the neck within the flange, and an independent catch adapted to lock said neck and flange together to prevent the disengaging movement of the neck, said catch consisting of a gravitating part hung from above and having a projection tending to enter coinciding holes in said flange and neck, whereby said gravity-catch must be lifted to withdraw said

projection before the globe-holder can be disengaged.

57. In an arc-lamp, a globe-holder having means for normally connecting it to the lamp-body and also connected therewith by a suspension-chain  $k$  having a terminal eye  $k'$ , said eye having a projection adapted to engage the globe-holder when the latter is in place to lock it against the disengaging movement, and adapted upon pulling said chain to be displaced to withdraw said projection and unlock said globe-holder.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

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APPLICATION FILED MAR. 26, 1902.

NO MODEL.

2 SHEETS—SHEET 1.

Fig. 6.

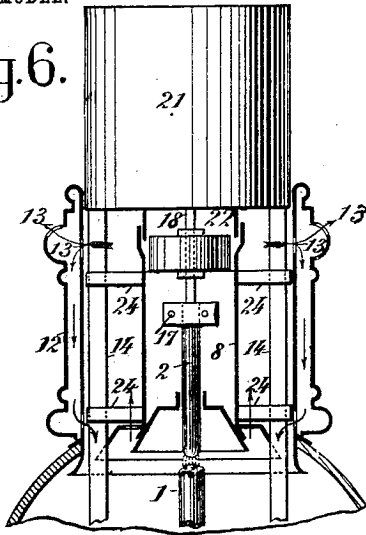


Fig. 8.

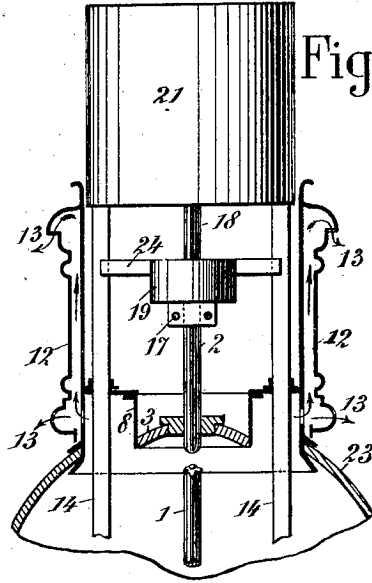


Fig. 1.

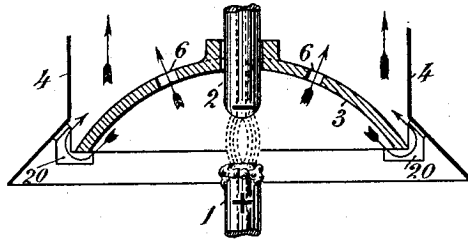
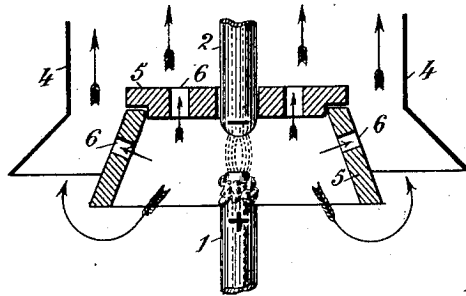


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 4.

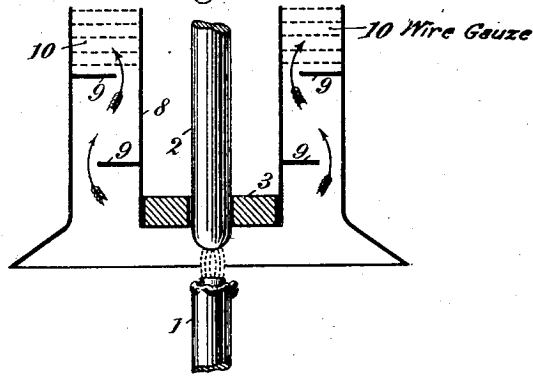


Fig. 3.

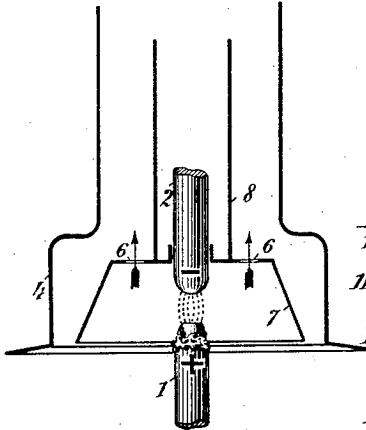


Fig. 5.

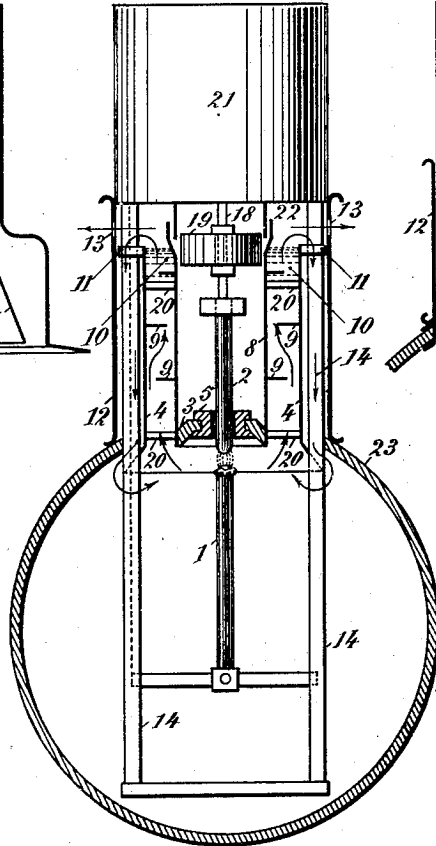
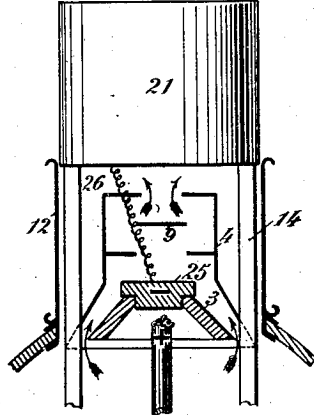


Fig. 7.



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# UNITED STATES PATENT OFFICE.

ANDRÉ BLONDEL, OF PARIS, FRANCE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 739,977, dated September 29, 1903.

Application filed March 26, 1902. Serial No. 100,024. (No model.)

*To all whom it may concern:*

Be it known that I, ANDRÉ BLONDEL, a citizen of the Republic of France, residing at Paris, France, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention has relation to an electric-arc lamp of the type or class wherein one or both of the carbons is or are combined with light-producing salts; and in such connection it relates to the construction and arrangement of the parts of the lamp whereby the composite carbons can be economically and advantageously employed.

Heretofore it was known that the luminosity of highly-incandescent carbons could be increased if the carbon is mixed with salts of lime, magnesia, or similar minerals. However, in the use of such carbons it has been found that certain disadvantages due to the nature of the carbon were present—namely, the production of melted scoria, the diffusion of vapors and smoke, and the unsteadiness of the light.

The principal objects of my present invention are, first, to provide in an electric-arc lamp two vertically-arranged carbons, one, the lower and positive carbon, being mixed with the light-producing salts, and the other, the upper electrode, either of carbon combined with a small percentage of these salts or of pure carbon and the upper carbon provided with a refractory shield or plate encircling the carbon above the arc formed between the carbons; second, to provide in an electric-arc lamp, in addition to the two carbons and the refractory shield or plate upon one of said carbons, a smoke-consumer or draft-passage located concentrically with the carbon upon which the refractory shield or plate is arranged, and, third, to provide in an electric-arc lamp, wherein a composite carbon is opposed to a substantially pure carbon, a combined means for preventing the accumulation of scoria upon the carbons and the diffusion of smoke and vapors about the luminous center of the lamp, as well as for securing an increase in the luminosity of the arc by refraction.

The nature and scope of my invention will be more fully understood from the following description, taken in connection with the ac-

companying drawings, forming part hereof, in which—

Figure 1 is a vertical sectional view illustrating diagrammatically the carbons, refractory shield, and smoke-conveyer embodying main features of my invention. Figs. 2, 3, and 4 are views similar to Fig. 1, but each illustrating a modified form of the invention. Fig. 5 is a vertical sectional view, partly in elevation, of a lamp wherein the invention is embodied in a still further modified form; and Figs. 6, 7, and 8 are views similar to Fig. 5, but each illustrating a still further modified arrangement of carbons, refractory shield, and smoke-conveyer.

Referring to the drawings, and particularly to Fig. 1, the lower carbon 1 is preferably the positive electrode of a continuous-current lamp, and as such it consists of carbon mixed with the light-producing salts either in block or having a core of such composite carbon surrounded by pure carbon. This lower carbon 1 in an alternating current is the alternative electrode. The upper carbon 2 is preferably the negative electrode of a continuous-current lamp, and as such it is essentially of pure carbon with a slight percentage of the light-producing salts either in block or in its core. It may, if desired, be formed of pure carbon with a composite covering. In alternating-current lamps this carbon 2 is an alternative electrode. Upon this upper or negative carbon 2 is arranged a shield or plate 3, of refractory material or metal. This shield or plate may be of any preferred shape or form, as illustrated in the various figures of the drawings, so long as it accomplishes the twofold function or purpose of protecting the upper carbon 2 from vapors arising from the arc by condensing said vapors on its under surface, as well as reflecting the light from above the arc downward from that surface upon which the vapors are condensed. In Fig. 1 the plate or shield 3 is spherical and is provided with openings 6, through which those vapors may escape which are not condensed upon the shield or plate. Concentric with the rim or lower edge of the plate or shield 3 is a tube 4, having a lower flaring or conical edge extending, preferably, below the shield or plate 3. This tube 4 forms a flue or chimney into which the smoke is drawn upward, as indicated by

the arrows. The tube 4 also forms, preferably, the support for the plate or shield 3, having for this purpose the brackets or claws 20, on which the lower edge or rim of the plate or shield 3 rests.

In Fig. 2 the construction is substantially the same as in Fig. 1 with the exception that in this form the refractory plate or shield 5 is cup-shaped and inverted over the arc formed between the carbons 1 and 2. The base and conical walls of the cup-shaped plate or shield 5 are both perforated, as at 6, to permit the escape of the vapors to the interior of the tube 4.

In Fig. 3 the shield or plate 7 is of inverted-cup shape, as in Fig. 2; but in this form of the device a tube 8, concentric with the upper carbon 2, projects from the roof of the shield 7 and surrounds the carbon 2 to protect it from the smoke and vapors in the smoke-conveyer 4, which surrounds the tube 8.

In Fig. 4 the shield 3 is flat and arranged at the base of the tube 8. Between the tube 8 and the encircling smoke-conveying tube 4 are arranged baffle-plates 9 and wire-gauze 10, through which the smoke and vapors must pass to facilitate the deposit of soot from the smoke.

In Fig. 5 the general arrangement of a lamp is illustrated. In this figure the shield or plate 3 projects downward from a collar 5, secured to the carbon 2, and is inclosed by the tube 8, which protects the carbon 2 from the smoke and vapors in the conveyer 4. The conveyer-tube 4 has claws or brackets 11 encircling the vertical supporting-tubes 14 of the lamp and are adapted to slide thereon to form a means for elevating or lowering the conveyer 4 with respect to the arc between the carbons 1 and 2. The holder 15 for the lower carbon 1 consists of a cross-bar sliding in the tubes 14. Through one of said tubes 14 extends a chain 16, connecting the feeding mechanism (not shown) with the lower-carbon holder 15. The smoke-conveyer 4 is surrounded by the casing 12 of the lamp and is by preference perforated, as at 13, above the discharge from said conveyer 14. The rod 18 of the upper-carbon holder 17 is operated by a feeding mechanism, (not shown,) and to the rod 18 is secured a counterweight 19, both weight 19, carbon-holder, and upper carbon 2 sliding up and down in the protective tube 8. The conveyer-tube 4 supports the protective tube 8 through the intermediary of claws or brackets 20. The feeding mechanism for the carbons 1 and 2 is inclosed in the casing or shell 21. The tubes 8 and 4 slide up and down, as before explained, upon the supporting-tubes 14 of the lamp, and when an upper carbon 2 is to be replaced both tubes 4 and 8 are lowered sufficiently to permit of access to the carbon 2 and its holder 17. A short tube 22 serves to close the upper end of the protective tube 8 when the same is elevated into operative

position. A globe 23 incloses the arc between the two carbons.

In Fig. 6 the construction is similar to that illustrated in Fig. 5 with the exception that the smoke-conveyer consists of the casing or shell 12 of the lamp.

In Fig. 7 the principal difference between the modification shown and the modifications of the other figures consists in replacing the upper negative carbon 2 by a block 25 of pure or substantially pure carbon or of refractory material mixed with carbon and with a metal. In this form, 26 represents the conductor leading the current to the negative pole or block 25.

In Fig. 8 a still further modification of the lamp is illustrated, wherein the protecting-tube around the upper carbon is dispensed with. In this form, however, the space where in the carbon 2 slides is inclosed by the casing 12, the casing 21 and the shield or plate 3, supplemented by the tubular extension 8, and plate 27 on said shield or plate 3. In this form the passage for the escape of smoke or vapors is formed in the casing 12, having outlets 13.

The advantages of the above-described arrangement are many. By placing the composite positive carbon below the upper and negative carbon a curious phenomenon arises, which explains why but small results were obtained heretofore from continuous-current arcs in which the composite alternative or positive carbon was arranged above the negative carbon. As is well known, the luminous mineral vapors have a tendency to rise and to separate themselves from the carbon or smoke vapors when the current flows from the upper to the lower carbon. The arc in this instance is luminous only in its upper part near the upper carbon. When, however, the composite carbon is placed below the upper negative carbon, the ascending current heats the luminous vapors during the whole of their course, and when assisted by the shield or plate 3 this results in an increase of the total luminous flux of from twenty-five to forty per cent. in similar lamps and from one hundred to three hundred per cent. in other arc-lamps. Again, when the composite carbon is placed below it is no longer licked by the flame, and hence produces less scoria. The scoria produced runs off the carbon without falling into the arc. The upper carbon being substantially pure produces no troublesome globules of scoria.

To increase the steadiness of the light, it is preferable in alternating-current lamps to place in both carbons a core containing alkaline salts, such as tartrates, carbonates, &c., of sodium or potassium, &c. The combining of a small percentage of light-producing salts with the carbon of the upper electrode is of little value in continuous-current lamps except perhaps in reducing the consumption of the upper carbon. In alternating-current

lamps, however, the combining of each carbon with the light-producing salts assists in increasing the luminosity of the arc. In such instances the lower carbon should contain 5 from thirty to sixty per cent. of mineral substance, whereas the upper carbon should contain from but five to twenty per cent. of the salts of lime, &c., or a core of large diameter 10 containing a considerable quantity of this substance. In any case the special feature is a composite lower carbon. In addition to the advantages arising from the composition and arrangement of the two carbons the shield or plate around the upper carbon above the arc 15 has several useful advantages. Thus it protects the upper carbon from the action of the flame, the ordinary function of a shield. Again, it condenses on its under surface adjacent to the arc a large proportion of the 20 mineral vapors, which form upon the shield or plate a white reflecting coating or layer. Being of refractory material and having a reflecting surface, the employment of such a shield corrects any appreciable loss of light 25 which might result from placing in continuous-current lamps the positive carbon below the negative carbon, and the effective luminous flux still remains from twenty-five to forty per cent. greater than if in a reverse arrangement of the electrodes, even if a shield 30 is used in such reverse arrangement. Its reflecting-surface renders the light uniform by diffusing nearly the same quantity at all times in all directions in spite of the displacement 35 of the arc around the carbons. Again, the shield or plate places the arc so that it is protected against cooling and currents of air, holds back the vapors, and renders the arc steadier. Thus, with this arrangement and 40 the carbons arranged in the manner indicated above, steady arcs of ten to twenty-five millimeters and more, under tensions of thirty to fifty volts and beyond this, may be formed, thus obtaining the maximum useful effect.

45 The smoke-consumer, which may be dispensed with in certain cases, consists substantially in a conical or cylindrical flue or chimney surrounding the shield or plate, so as to collect and carry upward by suction through 50 the action of a draft the mineral vapors which escape from it by the lower rims. Holes may also be pierced in the shield or plate, for facilitating this outlet of the vapors; but the chimney produces a useful effect, which would 55 not be obtained by holes alone without chimneys. The smoke-consumer may vary in height or be reduced to a simple collar. It may be employed at the same time as an outer covering for the lamp, Fig. 6.

60 In general it is an advantage to attach it to the interior cylindrical or conical protecting-tube which supports the shield or plate and surrounds the upper carbon, so as to place it beyond the reach of the air or the vapors.

65 The vapors are drawn up into the circular space or flue comprised between the two tubes and can be caused to deposit themselves here

almost entirely by means of baffle-plates or wire-gauze.

It will be observed that the mechanism con- 70 tained in the casing box or shell 21 in Figs. 5, 6, 7, and 8 is completely isolated from the mineral vapors. This mechanism may be of any kind upon condition of its satisfying two requirements—viz., insuring a much greater 75 extension of the electric arc than in ordinary lamps and giving the upper carbon a forward motion proportional to the extent to which it is worn out, which in general takes place less 80 quickly than in ordinary continuous-current lamps, in which the positive carbon is above.

The arrangements described are capable of a number of modifications which do not alter the essential characteristics described above. In particular the smoke-consumer may be 85 plain or enameled, as a reflector. It may have a great variety of forms, as may also the shield or plate. The substance of which this latter is composed may also be considerably varied. The baffle-plates may be cylindrical or conical, or be dispensed with, as in Fig. 6, or, 90 again, chambers for condensing vapor may be placed outside in the covering 12, into which the gases are conveyed for the purpose of condensing them, as shown by Figs. 6 and 8. 95 Likewise the shield or plate may be made according to circumstances of plain or enameled metal, porcelain, refractory earth, carbon, lime, magnesia, &c., or a mixture of these substances. The carbons themselves may be 100 formed of a very large core containing a considerable quantity of salts of lime, magnesia, &c., in place of being treated so in the block.

Having thus described the nature and objects of my invention, what I claim as new, 105 and desire to secure by Letters Patent, is—

1. In an electric-arc lamp, a lower electrode, comprising carbon combined with light-producing salts, an upper electrode and a shield or plate located around the upper electrode 110 above the arc formed between said electrodes.

2. In an electric-arc lamp, a lower electrode formed of carbon combined with light-producing salts, an upper electrode, and a shield or plate of refractory material located on said 115 upper electrode above the arc formed between said electrodes, said shield or plate having a surface to receive and condense the mineral vapors arising from the arc.

3. In an electric-arc lamp, a lower electrode 120 consisting of a pencil of combined carbon and light-producing salts and an upper electrode formed of a block of carbon or carbon composition, said upper electrode having an under surface for the reception and condensation of 125 the mineral vapors arising from the arc between the electrodes.

4. In an electric-arc lamp, a lower electrode formed of carbon combined with light-producing salts, an upper electrode formed of a block 130 of refractory carbon composition and a shield forming an extension of the upper electrode, said upper electrode and shield having a surface for the reception and condensation of

the mineral vapors arising from the arc between the upper and lower electrodes.

5 In an electric-arc lamp, a lower electrode formed of carbon combined with light-producing salts, an upper electrode, a shield or plate located around said upper electrode adjacent to the arc formed between the electrodes and having a surface for the reception and condensation of mineral vapors arising from said arc, and a protecting-tube extending upward 10 from said shield or plate and inclosing the upper electrode.

6. In an electric-arc lamp, a lower electrode formed of carbon combined with light-producing salts, an upper electrode, a shield or plate located around said upper electrode adjacent to the arc formed between the two electrodes, and a smoke-conveyer surrounding the upper electrode and shield or plate and having an inlet adjacent to the arc formed between said electrodes. 15

7. In an electric-arc lamp, a lower electrode formed of carbon combined with light-producing salts, an upper electrode, a shield or plate located around said upper electrode adjacent to the arc formed between said electrodes, a tube surrounding the upper electrode and located above the shield or plate, and a smoke-conveyer surrounding said tube and shield or 20

plate and having an inlet adjacent to the arc formed between the two electrodes. 30

8. An electric-arc lamp with electrodes partly composed of metal, and in which the negative electrode is above the positive, and the lower or positive electrode contains at least five per cent. and the upper or negative one less than five per cent. of metal, for the purpose of lessening the formation of the slag at the negative electrodes, preventing the falling of slag on the positive electrode, and increasing the length of the arc. 35 40

9. An arc-lamp, with electrodes partly composed of metal, and in which the negative electrode is above the positive and the lower or positive electrode contains at least five per cent. of metal and the upper or negative one less than five per cent. with an annular reflector, which surrounds the upper electrode, close to the arc, for the purpose of preventing the arc from being blown aside and upward, and thereby of steadying the arc. 45 50

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

ANDRÉ BLONDEL.

Witnesses:

C. MATHIEUY,  
J. ALLISON BOWEN.



No. 751,025.

PATENTED FEB. 2, 1904.

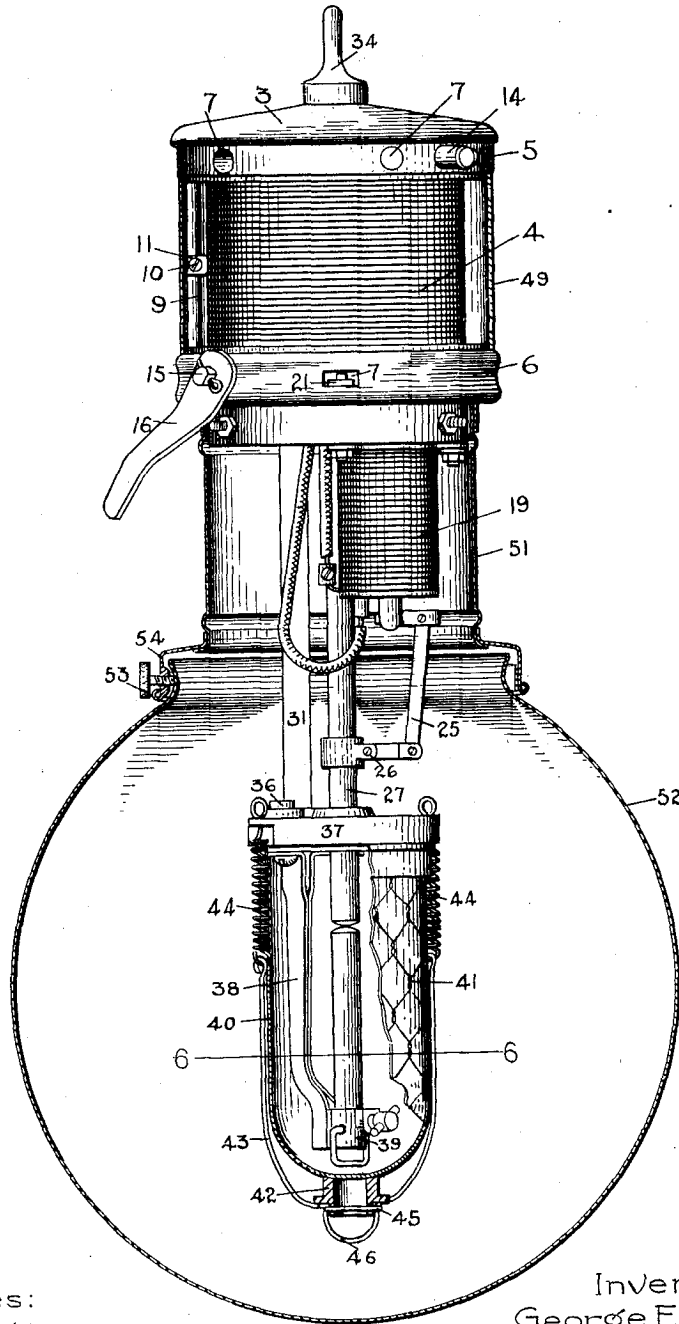
G. E. STEVENS & W. C. FISH.  
ELECTRIC ARC LAMP.

APPLICATION FILED JUNE 14, 1902.

NO MODEL.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

*Robt. Schopman*  
*Alex. F. Macdonald*

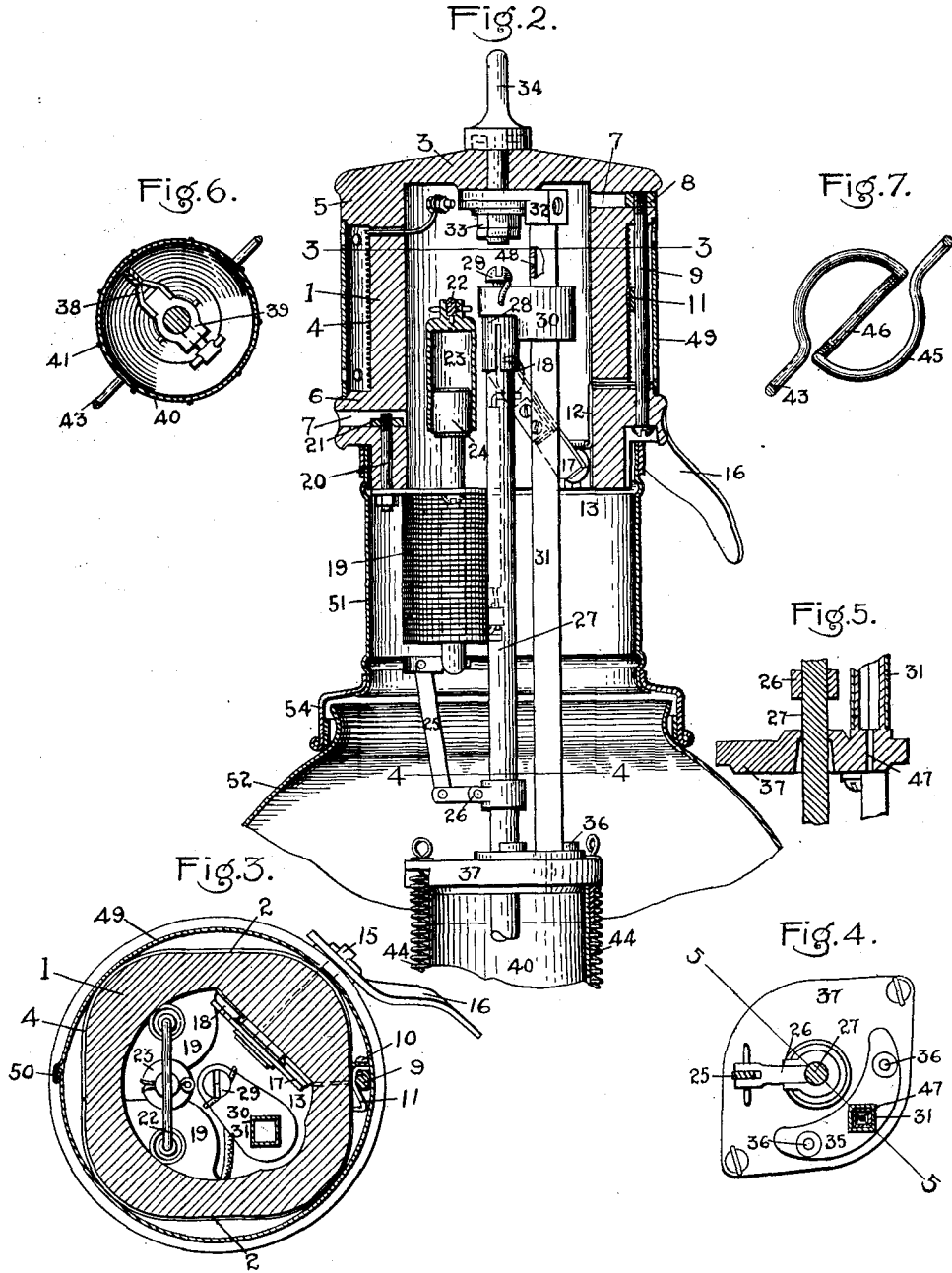
Inventors.  
George E. Stevens,  
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*Allen H. Bain* Att'y.

G. E. STEVENS & W. C. FISH.  
ELECTRIC ARC LAMP.

APPLICATION FILED JUNE 14, 1902.

NO MODEL.

2 SHEETS—SHEET 2.



Witnesses:

*Robt. Chapman*  
*Alex. Macdonald*

Inventors.

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By *Albert S. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

GEORGE E. STEVENS AND WALTER C. FISH, OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF  
NEW YORK.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 751,025, dated February 2, 1904.

Application filed June 14, 1902. Serial No. 111,635. (No model.)

*To all whom it may concern:*

Be it known that we, GEORGE E. STEVENS and WALTER C. FISH, citizens of the United States, residing at Lynn, county of Essex,  
5 State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

This invention relates to electric-arc lamps, its object being to cheapen the cost of man-  
10 ufacture and simplify the construction of the lamp. To this end the lamp is largely constructed of porcelain or other insulating material and sheet metal or punched metal fittings.

15 The features of novelty will be apparent from the following description.

In the accompanying drawings, Figure 1 is a side elevation of our improved lamp, the casing and globes being in section. Fig. 2 is  
20 a longitudinal sectional elevation of the upper part of the lamp and its mechanism. Fig. 3 is a cross-section of the same on the line 3 3, Fig. 2. Fig. 4 is a cross-section on the line 4 4, Fig. 2. Fig. 5 is a vertical section on the line 5 5, Fig. 4. Fig. 6 is a cross-section  
25 on the line 6 6, Fig. 1; and Fig. 7 is a plan of the finger-loop at the lower end of the support for the inner globe.

The upper part of the lamp is a tubular  
30 block 1 of insulating material, such as porcelain, preferably made with flattened sides 2 and having a closed top 3. Around the outside of this tubular body is wound the resistance-coil 4, confined between upper and lower  
35 flanges 5 6. At certain points in each flange are radial holes 7, one of which receives a nut 8 for a bolt 9, which passes lengthwise of the body 1 through the flange 6 and into the flange 5, where it engages with the nut 8.  
40 Secured to the shank of said bolt by a set-screw 10 is a slide 11, which bears upon the coil 4. The bolt 9 is connected by a lead 12 with a contact 13 inside said body. The other end of the resistance-coil is connected with a  
45 binding-post 14 on the outside of the body.

The cut-out switch is made as follows: In a radial hole in the body 1 is journaled a shaft 15, whose outer end carries a handle 16 and

whose inner end is provided with a contact-  
blade 17, adapted to connect or disconnect the  
50 contact 13, and another contact 18, forming one terminal of the lamp-solenoids 19. These solenoids are suspended below the body 1 by one or more bolts 20 passing up into the body and engaging with nuts 21 in the radial holes 7.  
55 The armatures of the solenoids are united at their upper ends by a yoke 22, from which is suspended a dash-pot 23, cooperating with a stationary plunger 24, rising from the top of the solenoid-frame. Their lower ends are con-  
60 nected by a link 25 with a pivoted dog-clutch 26. The upper carbon 27, on which said clutch operates, is suspended from a sheet-metal holder 28, attached by a screw 29 to an insulating-  
65 guide 30, preferably made of porcelain and arranged to slide on an upright tubular metal rod 31, whose upper end is provided with a bracket 32, clamped to the under side of the top 3 of the body by the nuts 33, which secure  
70 the hanger 34 to said top. The rod 31 is preferably polygonal, as shown, to prevent the guide 30 from twisting thereon. Its lower end has a foot 35, secured by screws 36 to the gas-cap 37, which is preferably made of insulating material, such as porcelain. Depend-  
75 ing from its under side is a metal leg 38, which carries at its lower end the lower-carbon holder 39.

The inner globe 40 is incased in a wire-netting guard 41, which at its lower end connects  
80 with a metal or porcelain collar 42, in which the lower end of the globe rests, the collar being supported by a wire bail 43, connected by springs 44 with the gas-cap and having at its lower end an integral ring 45 for the collar  
85 and a loop 46 for a finger-hold to facilitate pulling it down to release the globe.

There is a small passage 47 through the gas-cap into the tubular rod 31, and at the upper  
90 end of the rod is a small hole 48. This makes the interior of the rod a passage for the escape of gas from the inner globe, and as the rod will hold a considerable volume of gas it acts as a reservoir for the hot gases and prevents the entrance of cold air into the globe.  
95 It will be observed that the rod 31 performs

several functions, to wit: It is a frame or backbone for the lamp and by means of it nearly all the parts are suspended directly from the hanger 34. It guides the upper carbon and forms part of the negative lead, the negative binding-post of the lamp being connected with the bracket 32, and it carries the gas-cap and inner globe and forms a gas-chamber. If the porcelain body 1 should be broken, the rod 31 will support all the mechanism and prevent the parts from dropping to the ground.

The resistance-coil is incased in a ventilated jacket 49, composed of a sheet of metal having doubled edges 50, which hook together when they meet, as shown in Fig. 3. Attached to the lower end of the body is a sheet-metal jacket 51, inclosing the solenoids and affording a support for the outer globe 52, which is held by set-screws 53, passing through a flange 54 of said jacket.

This lamp is very simple in construction and can be cheaply and rapidly manufactured.

What we claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an arc-lamp, a tubular body of insulating material, having a closed top, a hanger secured to said top, a resistance-coil wound on said body, openings in said body, leads from the resistance-coil extending through said openings, and means for varying the resistance in circuit.

2. In an arc-lamp, a tubular body of insulating material having a closed top and upper and lower flanges, a resistance-coil wound between said flanges, a bolt running lengthwise of said body outside of said coil, with its ends in said flanges, and a slide on said bolt.

3. In an arc-lamp, the combination, with a tubular body of insulating material, of a rod suspended from said body at a point laterally displaced from its axis, and upper and lower carbon holders supported by said rod in a position to hold the carbons in alinement with the axis of said body.

4. In an arc-lamp, the combination, with a tubular body of insulating material, of a rod suspended from said body, a guide sliding on said rod and extending laterally therefrom, an upper-carbon holder carried by said guide, and a lower-carbon holder suspended by said rod.

5. In an arc-lamp, the combination, with a tubular body of insulating material, of a polygonal rod suspended from said body, an insulating-guide sliding on said rod, a carbon-holder attached to said guide, a clutch for the carbon, and a solenoid for operating the clutch.

6. In an arc-lamp, the combination, with a tubular body of insulating material, of a rod suspended from said body at a point laterally displaced from its axis, and a gas-cap of insulating material attached to said rod with its center in the axis of the tubular body.

7. In an arc-lamp, the combination, with a tubular body of insulating material, of a tubular rod suspended from said body, and a gas-cap attached to said rod and having a passage communicating with the interior of said rod.

8. In an arc-lamp, the combination, with a tubular body of insulating material, of a tubular rod suspended from said body and having a hole near its upper end, and a gas-cap attached to said rod and having a narrow passage communicating with the interior of said rod.

9. In an arc-lamp, the combination, with a tubular body of insulating material, of a rod suspended from said body, a gas-cap of insulating material attached to said rod, and a lower-carbon holder depending from said gas-cap and in direct electrical connection with said rod through the gas-cap.

10. In an arc-lamp, the combination of a top, a rod suspended therefrom, a gas-cap of insulating material secured to said rod, a lower-carbon holder depending from said gas-cap, and a metallic connection through the gas-cap between the rod and carbon-holder.

11. In an arc-lamp, a top, a rod suspended therefrom, means for holding the upper carbon parallel to and laterally displaced from said rod, and a gas-cap and a lower-carbon holder supported by said rod.

In witness whereof we have hereunto set our hands this 12th day of June, 1902.

GEORGE E. STEVENS.  
WALTER C. FISH.

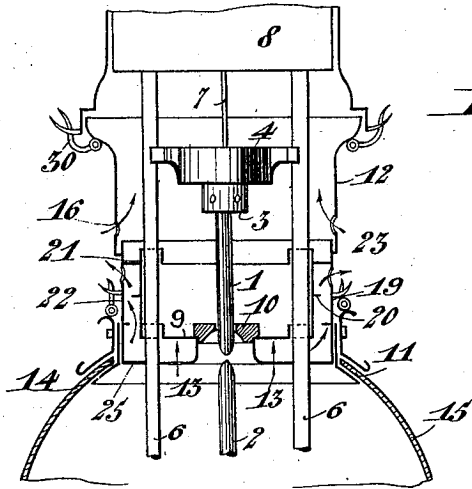
Witnesses:

DUGALD MCK. MCKILLOP,  
ALEX. F. MACDONALD.

A. BLONDEL.  
ELECTRIC ARC LAMP.  
APPLICATION FILED NOV. 10, 1903.

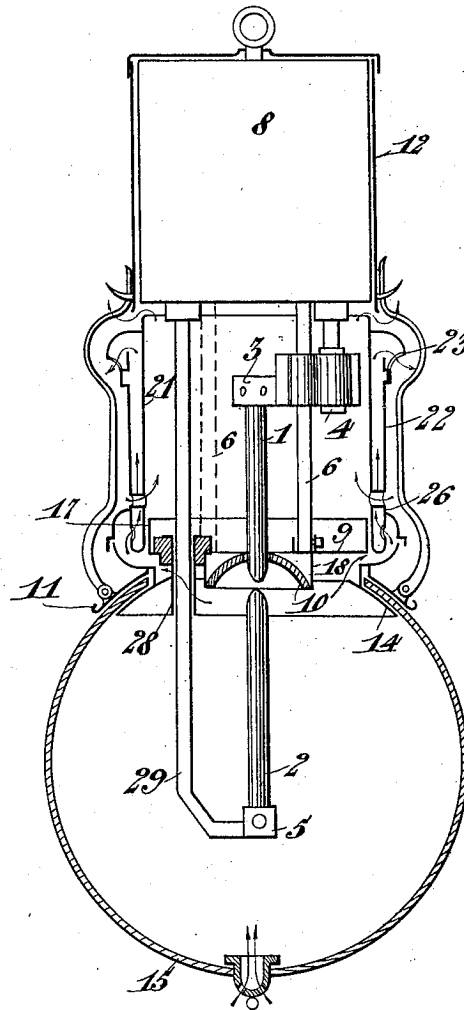
NO MODEL.

2 SHEETS—SHEET 1.

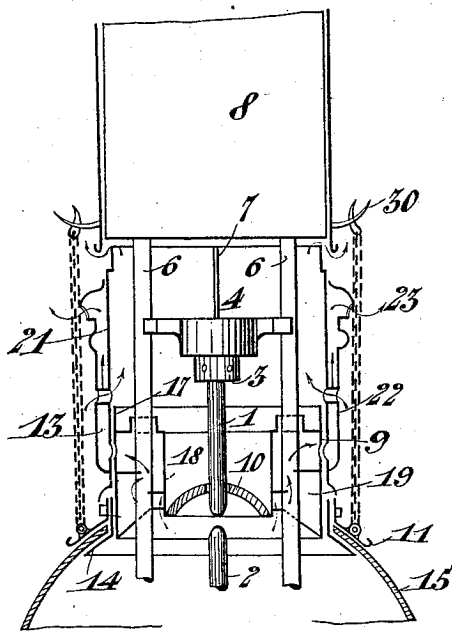


*Fig. 1.*

*Fig. 2.*



*Fig. 3.*



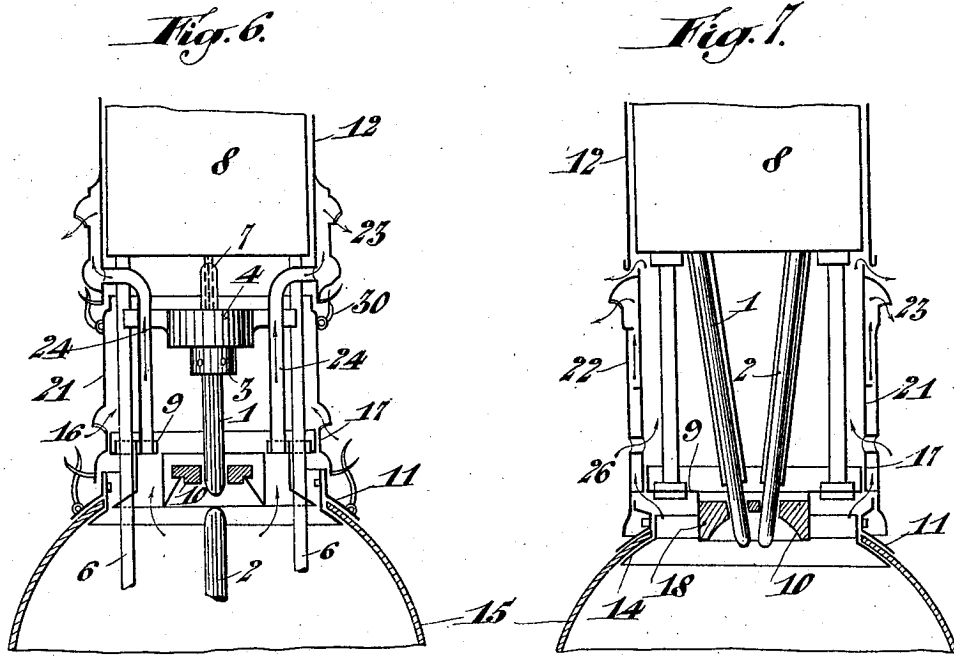
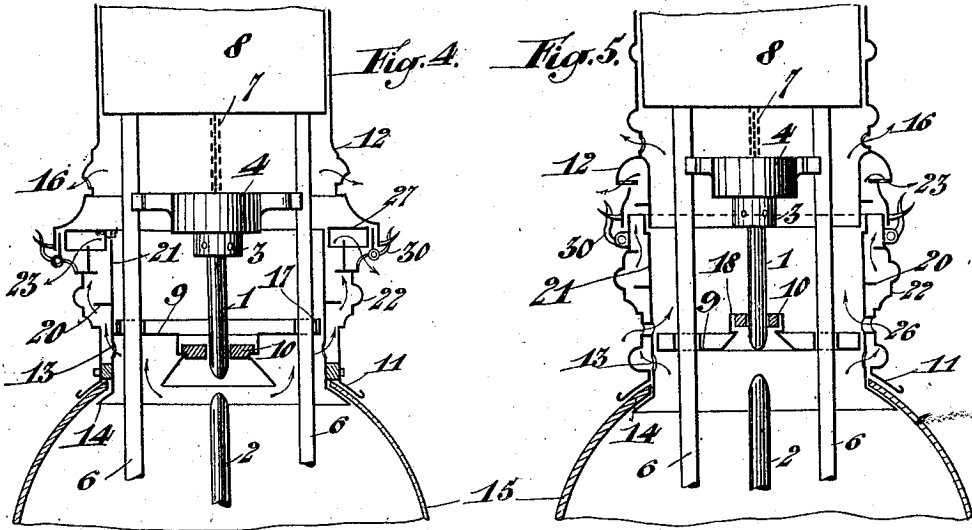
Witnesses  
Thomas Kirkpatrick  
H. van Heerenbrinck

Inventor  
André Blondel  
by Henri van Oldenweel  
Attorney

A. BLONDEL.  
ELECTRIC ARC LAMP.  
APPLICATION FILED NOV. 10, 1902.

NO MODEL.

2 SHEETS—SHEET 2.



Witnesses  
Thos. Kirkpatrick  
H. van Heerenbrinck

Inventor  
André Blondel  
by Henri van Oldenmeel  
Attorney

# UNITED STATES PATENT OFFICE.

ANDRÉ BLONDEL, OF PARIS, FRANCE.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 756,460, dated April 5, 1904.

Application filed November 10, 1902. Serial No. 130,794. (No model.)

*To all whom it may concern:*

Be it known that I, ANDRÉ BLONDEL, engineer, a citizen of the French Republic, residing at Paris, France, have invented new and useful Improvements in or Relating to Electric-Arc Lamps with Mineralized Electrodes; and I do hereby declare the following to be a full, clear, and exact description of the same.

My said invention relates to arc-lamps embodying mineralized electrodes and a protecting-casing; and the object of the invention is to provide an improved construction capable of allowing the escape of the fumes produced by mineralized electrodes without access to the mechanism and the introduction of fresh air into the mechanism and giving easy access for the introduction of the carbon and to generally improve the various parts.

In the drawings, Figure 1 shows a fixed double envelop 21 22, which incases the part of the lamp above the horizontal partition 9 and which is traversed by the vapors coming from the lower openings 13 and flowing to the upper outlets 23. Fig. 2 shows a movable double casing which can be separated from the partition 9, upon which it is mounted. Fig. 3 shows a combination of the two above-described constructions wherein the double casing 21 22 is mounted upon a fixed condensation-chamber 18 19, with the openings 13 opposite to one another. Fig. 4 is a modification of Fig. 2, in which the double casing 21 22 covers only a part of the height of the lamp. Fig. 5 is another modification in which the double casing consists of two parts incasing one another. Fig. 6 shows a further construction wherein the double casing is arranged still higher and receives the vapors through tubes 24 of any desirable number, the lower ends of which extend through the partition 9 and the upper ends of which terminate in the double casing 21 22. Finally, Fig. 7 shows the application of the same arrangement to lamps with the carbons placed side by side, so as to inclose the space containing the carbons and also the mechanism, a double casing 21 22, adapted for the removal

of the vapors, being shown independent or connected to the globe or to the base. In these figures the numerals indicate the various parts as follows:

- 1 and 2 are the carbons.
- 3 is the upper-carbon holder. 4 is the counterweight accompanying it.
- 5 is the lower-carbon holder.
- 6 represents the guide-rods, of any desired number, one of these being hollow for the introduction of the chain, string, or rod which supports the lower-carbon holder.
- 7 is the rod, cord, or chain supporting the upper-carbon holder.
- 8 is the closed box containing the usual mechanism.
- 9 is the horizontal partition, which is flat, conical, or curved and consists of refractory material or plain or enameled metal and which completely separates the upper-carbon holder from the zone of the arc in such a manner that no vapors coming from the latter can ascend above the carbon-holder 3 nor reach the mechanism 8. 10 is the economizer supported by this partition 9 or directly attached to the rods 6.
- 11 is the metal crown fixed above the opening of the globe.
- 12 is a simple casing surrounding the space containing the upper-carbon holder.
- 13 represents the outlet-openings for the fumes contained in the globes.
- 14 is an internal collar on the globe (fixed to the latter or to the partition 9 or to the rods) and serving eventually as a reflector, being enameled or not, as in the case of the partition 9 and the economizer 10.
- 15 is the globe.
- 16 represents openings for the circulation of the air in the casing 12.
- 17 is a vertical cylindrical flange of the partition 9, against which the casing is tightly adjusted.
- 18 is a tubular socket arranged in the partition 9 and carrying the economizer 10.
- 19 is the fixed condensation-chamber mounted upon the partition 9.
- 20 represents offsets or partitions for cool-

ing and condensing the vapors; 21 22, concentric walls forming the double casing or cover between which the fumes escape through the openings 23; 24, outlet-tubes, which up to a certain height can replace the double casing.

25 is the supplementary partition arranged parallel to the partition 9, so as to form the condensation-chamber.

26 represents tubular openings arranged across the walls 21 22 of the double casing and having the object of allowing fresh air to penetrate into the lamp without mixing with the fumes.

27, Fig. 4, is a movable annular cover, which can be lifted off the double casing, so as to facilitate the cleaning.

28 is a guide-socket in lamps with movable rods 29, Fig. 2, and arranged beneath the partition around the movable rod in order to protect it from the fumes which settle down upon the socket.

30 indicates the means of attachment—such as bolts, rods, or chains—arranged to connect the various parts of the lamp, globe, casings, base, &c.

As can be seen from the figures, the invention is characterized by the combination with a horizontal partition generally provided with a large economizer of a casing with double walls 21 22, which are connected together and leave between them a passage for the fumes entering from below and escaping above. These double casings can have a height greater or less with regard to the lamp, and they can be made of one or several parts combined or not with fixed condensation-chambers or simple casings. The double casings can be fixed, Fig. 1, or independent, Fig. 2, and they can be held on the base or the globe with the aid of any means of attachment. They can also be connected once for all to the base, Fig. 6, or more conveniently to the globe, Figs. 4 and 5. They fit tightly round the partition 9 either by simple jamming or with the aid of a flexible packing of metal, asbestos, or the like, as used for the joints of any machinery. Their height is sufficient for the production of a draft of gas, and the fresh air can penetrate into the globe through the ash-receiver or through the openings in the crown 11. The openings for the admission of fresh air into the lamp allow of cooling the internal walls of the double casings, and the vapors which traverse these casings between two cold walls are more completely condensed than in any other apparatus. In order to increase the condensation, projections or partitions 20 can be arranged in the casings in the path of the gases, thereby forcing the latter to pass over them, while metallic screens or filters of asbestos, felt, or the like can also be used without hindering the discharge of the vapors, as a very powerful draft is obtained. Owing to this draft, the gases do not tend to ascend into

the lamp through the joint between the partition 9 and the casing 22; but this joint can be dispensed with, according to the arrangements shown in Figs. 1 and 6. In the latter the simple casings 12 can, if desired, be dispensed with and the space around the upper carbon can be kept open, thus insuring an excellent condensation of the fumes.

Besides the double casings the present invention contains other novel features relating to the arrangements of protectors and economizers. Fig. 2 shows the arrangement of a protecting-socket 28. Whenever a lamp has movable rods, they can be arranged so as to traverse the partition 9 with a slight friction through a tight opening provided with packing, which can be of insulating material—such as asbestos, mica, and the like; but this is not sufficient, as in proximity with the economizer the movable rod 29 becomes covered with fumes, which prevent it from smoothly sliding in the opening in the partition. For this reason these rods are at a certain height—for instance, two or three centimeters below the edge of the economizer—surrounded by a sleeve of any suitable material, which can be insulating or electrically insulated from the partition or from the rod. Thus the latter remains clean, and all the fumes can settle only on the protecting-sleeve.

As regards the partition of the economizer the novel point of the construction is that a circular opening is arranged at the center of the partition surrounded by a tube 18, which generally forms an integral part of the latter and which incases the economizer 10, which has the form of a disk or a dome or the like. Figs. 2, 3, and 7 indicate the simplest arrangement of this central tube, with a simple lower flange for the support of the cap 10. In Fig. 4 the tube is extended to form a conical reflector. In Fig. 6 this reflector is formed by a part of the tube, which is suitably bent. In Fig. 5 the tube 18 is bent at the top and not at the bottom and receives the economizer at its upper end. This cap or economizer consists of any suitable fire-resisting material. All these constructions can be used for lamps with metallic-coated carbons placed side by side, (one or both carbons being metallic coated,) as well as for those with the carbons placed one above the other. In each case, however, they offer the same advantages—viz., strong draft, rapid discharge of the fumes, and very perfect condensation of the latter, preservation of the mechanism, a simple and economical construction, a thorough ventilation in the interior of the lamp, and an easy detachment of the casings. In order to internally clean the latter, they can be made of several parts, detachable by the removal of screws or the like, or a detachable cover 27 can be constructed, as shown, for example, in Fig. 4. It is also sufficient to shake the casings from



time to time, so as to cause the deposited mineral matters to fall out through the openings 13 23.

I claim—

5 1. In arc-lamps the combination with a horizontal partition, of a double-walled vertical annular casing through which the vapors are drawn by natural draft, and in which they condense before their escape from the lamp, 10 suitable openings being provided for the ventilation of the interior of the lamp and the cooling of the inner wall of the annular casing substantially as described.

2. In combination in an arc-lamp with a hori-

zontal partition above the arc a double-walled 15 annular casing through which the vapors generated are forced to pass before escaping from the lamp, perforations in the lower and upper parts of said casing for said vapors, and tubular lateral passages through the wall of the casing 20 to admit fresh air, substantially as described.

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

ANDRÉ BLONDEL.

Witnesses:

GAËTAN DOBKEVISCH,  
EDWARD P. MACLEAN.

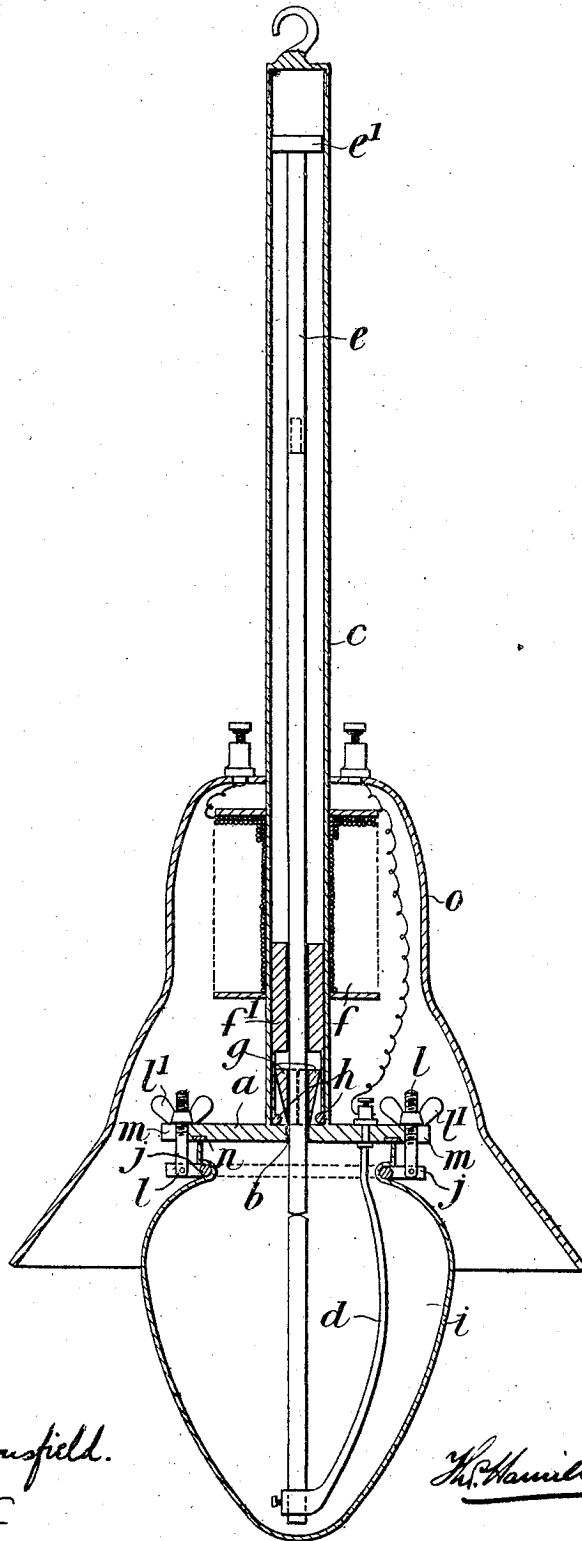
No. 774,876.

PATENTED NOV. 15, 1904.

T. HAMILTON-ADAMS.  
ELECTRIC ARC LAMP.

APPLICATION FILED AUG. 21, 1903.

NO MODEL.



Witnesses  
*John E. Dousfield.*  
*Asst. Inventor*

Inventor.  
*T. Hamilton-Adams*

# UNITED STATES PATENT OFFICE.

THOMAS HAMILTON-ADAMS, OF LONDON, ENGLAND.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 774,876, dated November 15, 1904.

Application filed August 21, 1903. Serial No. 170,287. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS HAMILTON-ADAMS, a subject of the King of Great Britain, residing at Howard House, Arundel street, Strand, London, England, have invented new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention relates to improvements in electric-arc lamps of the kind wherein the movable carbon is fed toward the fixed carbon by gravity and is raised by a solenoid core or armature, which directly or through the medium of a clutch automatically grips the carbon or holder when it is attracted by the solenoid, the object of my invention being to simplify the construction of such a lamp and to prevent the pressure generated within the lamp when inclosed from bursting or fracturing the lamp.

The accompanying drawing shows a vertical section of an electric-arc lamp constructed according to the invention.

The frame of the lamp comprises a foundation-plate *a*, having a central aperture *b* and a radiating-tube *c*, of non-magnetic material, fixed centrally on the said plate concentric with the hole *b* and capable of being closed at the upper end. This tube, which is of uniform diameter throughout, is of considerable length, so as to afford a relatively large area of surface for cooling the heated air contained in the lamp when inclosed to such an extent that the pressure will never rise to a dangerous point, thereby avoiding the necessity for using a valve or other device for relieving the air.

*d* is the holder for the lower or fixed carbon, and *e* the holder for the upper or movable carbon, the said holder *e* being of the same diameter as the upper carbon, which latter is reduced in diameter at one end, so as to fit into a socket in the lower end of the said holder. The upper end of the holder is provided with an enlargement *e'*, which slides against the sides of the tube *c*, which serves as a guide for the said holder, the lower end of the carbon being held in its proper position by passing through the central hole *b* in the foundation-plate. *f* is a solenoid-coil which is fixed on the exterior of the tube *c*,

and *f'* is the armature or core of the said coil, which is arranged within the tube *c* and provided with a central hole through which the upper carbon is free to slide. This armature-coil operates in conjunction with a clutch *g*, consisting of two gripping-pieces, which together form a kind of cone surrounding the carbon rod and designed to be acted upon by lugs or a projection-ring *h*, formed on extensions on the lower end of the armature *f'*.

*i* is the globe, upon which is secured a ring *j*, carrying a series of pivoted bolts *l*, designed to be engaged with slots *m* in the foundation-plate *a* and to be tightened against a packing-ring *n* in the under side of the said foundation-plate by means of thumb-nuts *l'* upon the said bolts *l*.

*o* is a shield or case which covers certain parts of the mechanism in a manner which will readily be understood with reference to the drawings.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an arc-lamp, the combination with the foundation-plate, of a globe hermetically united thereto, a radiating-tube hermetically united to said plate, communicating with the interior of said globe and extending outside of the lamp-body to radiate the heat produced by the arc, whereby the heated air and gases within the globe are permitted to continuously pass into the radiating-tube and give off their heat, thereby obviating the use of pressure-relieving devices, substantially as described.

2. In an arc-lamp, the combination with the foundation-plate provided with a guiding-aperture therein, of a globe hermetically united thereto, a radiating-tube hermetically united to said plate, communicating with said guiding-aperture and extending outside of the lamp-body, for radiating the heat generated by the arc, and obviating the use of pressure-relieving devices, and a movable carbon-holder guided in said tube, said tube and said guiding-aperture in said plate forming the guiding means for the movable carbon, substantially as described.

3. In an arc-lamp, the combination with the  
globe for hermetically inclosing the arc, of a  
hermetically-sealed radiating-tube communi-  
cating with said globe and extending outside  
5 of the lamp-casing, whereby the heated air and  
gases within the globe may continuously pass  
into said tube and be relieved of their heat  
thereby preventing an excess of pressure

within the globe and obviating the use of pres-  
sure-relieving devices, substantially as de- 10  
scribed.

THOMAS HAMILTON-ADAMS.

Witnesses:

JOHN E. BOUSFIELD,  
A. ALBUTT.

C. OLIVER.  
ELECTRIC ARC LAMP.  
APPLICATION FILED FEB. 29, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

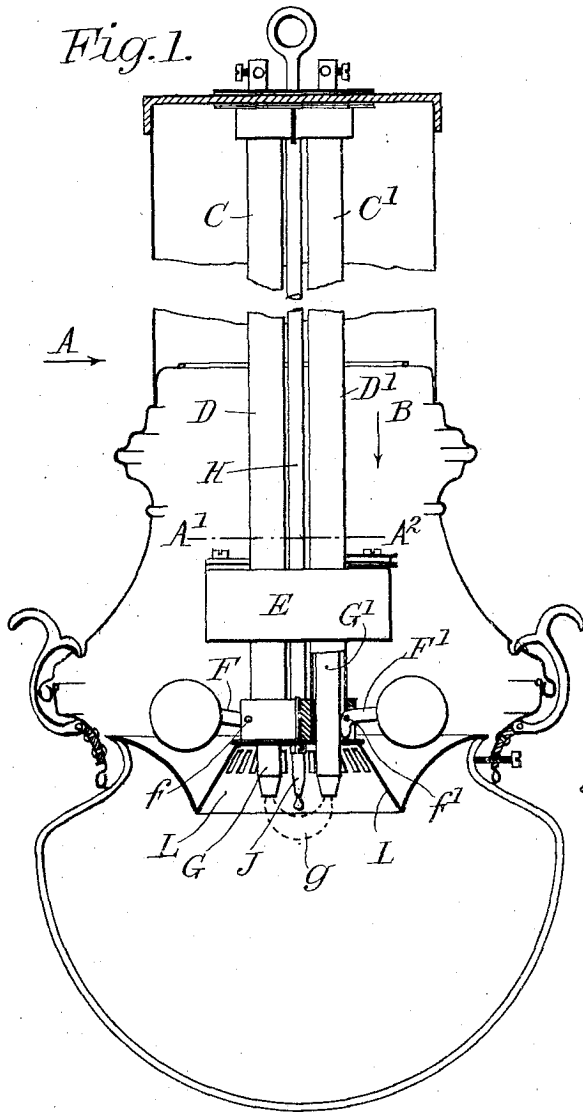


Fig. 2.

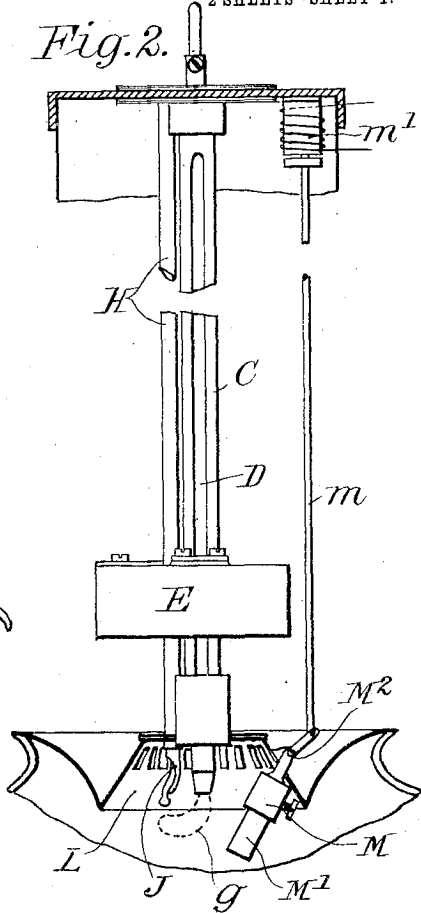


Fig. 8. Fig. 8a.

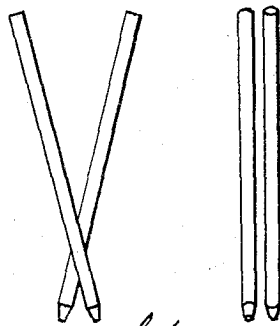
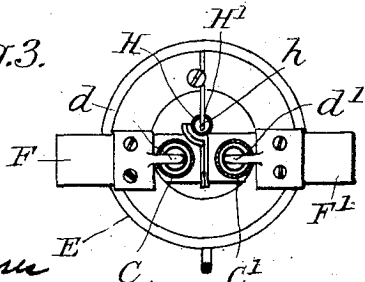


Fig. 3.

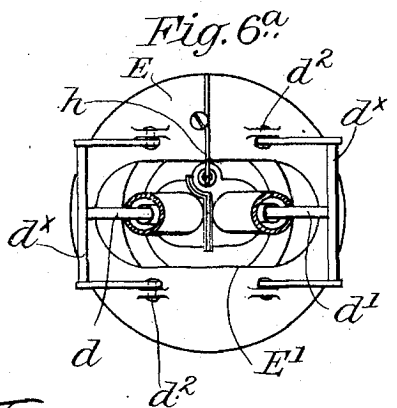
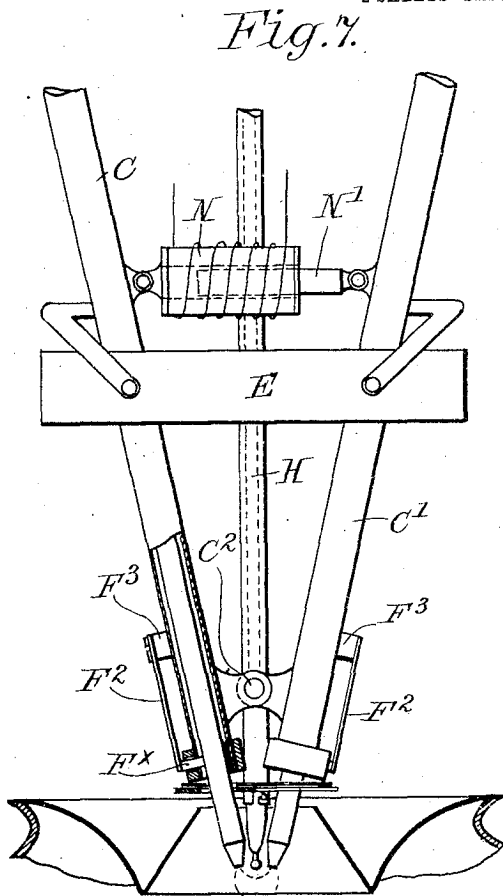
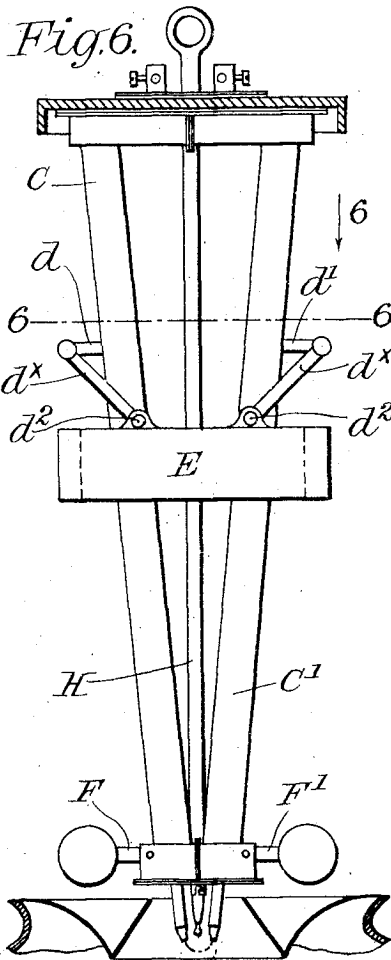


Witness  
 Stephen Kinster  
 W. Max. Duvall.

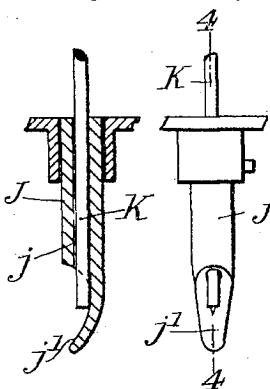
Inventor.  
 Charles Oliver  
 By Wilkinson & Fisher  
 his Attorneys.

C. OLIVER.  
ELECTRIC ARC LAMP.  
APPLICATION FILED FEB. 29, 1904.

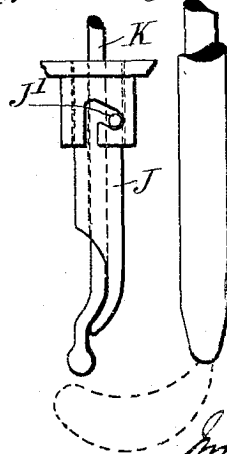
2 SHEETS—SHEET 2.



*Fig. 4<sup>a</sup> Fig. 4.*



*Fig. 5.*



*Witnesses:*  
*Stephen Bineta*  
*W. Max. Duvall.*

*Inventor*  
*Charles Oliver*  
*By Wilkinson & Firm*  
*his Attorneys.*

# UNITED STATES PATENT OFFICE.

CHARLES OLIVER, OF WOOLWICH, ENGLAND.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 785,516, dated March 21, 1905.

Application filed February 29, 1904. Serial No. 195,913.

*To all whom it may concern:*

Be it known that I, CHARLES OLIVER, electrical engineer, of the firm of Oliver & Co., a subject of the King of Great Britain, residing  
5 at Cambridge Place, Burrage Road, Woolwich, in the county of Kent, England, have invented certain new and useful Improvements in or Relating to Electric-Arc Lamps, of which the following is a specification.

10 In arc-lamps which burn with long luminous arcs and wherein the electrodes contain or are impregnated with metallic salts and are arranged parallel or inclined toward each other instead of vertically above one another, as is  
15 usual with the arcs burning at the lower ends of the carbons under a reflector and under magnetic influence or not, the mechanism hitherto in use for feeding them forward together to keep the arc in a fixed position has been  
20 complicated, expensive, and in many cases unreliable.

This invention is designed (*inter alia*) to overcome the above undesirable features, and a lamp constructed accordingly is exceedingly  
25 efficient, simple, and cheap to manufacture.

According to my present invention I provide carbons in pairs fixed either vertically or otherwise parallel to each other or inclined toward each other, but always in such a position that the arc can be formed between the  
30 lower end of each carbon, each of which has its burning-point pointing downward. A reflector or shield or top plate (hereinafter referred to as the "reflector") placed just above the points of the carbons where the arc takes  
35 place is advantageously of an inverted-cup form or other suitable form advantageously but not necessarily so that it incloses or partly incloses or surrounds or partly surrounds said  
40 points. It may be made either closed at the top or open or partly open, as required. Any suitable carbons or electrodes may be employed in lamps constructed according to the present invention, such lamps, however, being  
45 specially suitable for use with carbons or electrodes which produce a long luminous flame or arc, such as the present well-known flame carbons or electrodes which contain or are impregnated with metallic salts, and the  
50 use of which latter for the sake of example I

will hereinafter describe. The points of the carbons between which the arc is formed project from above through the top or sides of this reflector. The carbons are fed forward together as they burn away, their sizes being  
55 proportioned so that they consume evenly throughout. Contacts to carry the current to the carbons are provided just above the arc.

An insulated carbon holder or holders may be provided, into which the upper ends of the  
60 carbons are fixed or held and fed forward as required, or I may advantageously dispense with carbon-holders such as these and in their place provide an arrangement only for pushing forward the carbon or carbons, in which  
65 case I preferably make the contact devices above mentioned of such a strength as to hold the carbons by friction in their position except at such times as they are being fed forward through them. One advantage of this  
70 last arrangement is that the carbons do not require any special fastening. They are slipped into position from below, a tube being advantageously provided for each carbon into which to insert it.  
75

In order to start the arc between the carbon points, I employ a starting device, such as a bridge-piece, which acts as a conductor. For example, a small connecting-piece of carbon or other suitable conducting material is  
80 provided, which is automatically inserted between the carbon points to make a circuit and is automatically withdrawn when the current passes through them, so striking the arc by means which are readily understood, or the carbons  
85 are caused to touch each other, and when current passes they are separated and the arc is formed in the known manner.

In order to feed the carbons forward at the rate at which they burn away—that is, to keep  
90 the arc or "flame" in a certain fixed position in relation to the reflector—I provide a length of glass or other suitable material affected by heat—for example, a rod or rods of glass—of any suitable section or form advantageously  
95 arranged parallel to the carbons and of equal length, the lower end or ends of which will, owing to the gradual consumption of the carbons and the consequent adjacent position of the arc and heat therefrom, be caused to slowly  
100

soften or to fuse or to disintegrate or to be consumed thereby or to be so altered or affected continuously or otherwise during the burning of the carbons as to enable them to be  
 5 moved or operated in such wise as to keep the arc or flame located in the desired plane or position relatively to the reflector.

For the sake of example I will describe my present invention as carried into practice with  
 10 each pair of carbons provided with a single stick or rod of glass extending throughout the length of the said pair of attached carbons and parallel to them, such glass rod or stick being attached either directly or indirectly to the  
 15 said pair of carbons. For instance, the glass rod or stick may be fixed in or be operated on by the same holder or device or means, (such as a weight,) which hold or force down or operate on the pair of carbons. An abutment  
 20 or stop or other means are interposed in the path of travel of said glass rod at or near the point where the arc takes place, this stop, &c., consequently serving to normally prevent the descent of the glass rod, and thereby normally  
 25 preventing the descent of the attached pair of carbons. The glass rod is slipped into a slotted tube or other suitable guide specially provided for the purpose, so as to prevent its being bent or broken when under the action of  
 30 the feeding-weight.

The feed takes place as follows: The lamp having been started, as the carbon points burn away consequently the arc approaches or tends to approach toward the point where the stop,  
 35 &c., arrests the descent of the glass rod, and the heat from the arc gradually softens or melts or affects the lower end of the glass rod, and thereby allows a gradual descent of said glass rod, and consequently causes the descent  
 40 of the carbon pencils, and the further melting or softening of the glass ceases until the arc again approaches the aforesaid point, where the glass rod is controlled and the operation is repeated, and so on. In practice, however, the  
 45 carbon points come to rest at what I may term a "point of equilibrium," the glass rod being continuously but very gradually and steadily softened or melted or affected, and so continuously feeding the carbons and keeping the  
 50 lower-carbon points in the desired position—*i. e.*, practically in the same plane throughout the burning of the lamp. In practice I have successfully employed a short metal tube or sleeve or socket, the lower end of which is  
 55 provided with a curved piece or extension, against which the end of the glass rod normally rests and is arrested, and as the heat from the arc acts upon said lower end of said glass rod it is softened and descends the curved  
 60 plate or stop and is thereby bent, (and eventually this lower end of the glass rod melts away,) and so permits the gradual feed and steady descent of the carbons.

I find that both with alternating and continuous currents, but especially with alternat-

ing current, I obtain an advantage in slightly projecting or directing the arc or flame magnetically, or otherwise to one side of the carbons in the direction of the fusible rod for the purpose of directing its heat with greater certainty upon it to thereby feed the carbons  
 70 with greater reliability.

As a modification I may make the glass rod of longer or of shorter length than the carbons; but in such cases special gear must be provided in order that the glass rod may feed relatively to the carbons more slowly or more rapidly, as the case may be, or said fusible,  
 75 &c., rod or rods may be bent or of curved or of any other suitable formation, suitable means being provided within the lamp to feed the said rods or devices in order to feed the carbons in the aforesaid manner—that is, by the continuous melting or disintegration of the said rod or rods. Also instead of a weight  
 80 to force down the carbons the action of a spring may be employed for the same purpose.

In carrying this invention into practice in order to make or provide a long-hour or long-burning lamp I may arrange a plurality of pairs  
 90 of carbon pencils, each pair provided with a glass rod, &c., as aforesaid, for regulating the location of the arc, or, if desired, a single glass rod can be arranged to feed more than one pair of carbons, and I so arrange such plurality  
 95 of pairs of carbons that upon the burning of one pair of carbons being finished the current is then automatically switched or directed through another pair, and so on with each pair in the lamp, as will be readily understood.  
 100

In constructing my arc-lamp for working on constant-potential circuits when inclined electrodes are used instead of their being arranged parallel to each other it is necessary to employ automatic means to keep the voltage  
 105 across the points of the carbons constant or practicably constant, as there is a disturbing element in that an arc of higher or lower temperature (such as one of higher or lower voltage, and consequently also varying current)  
 110 will influence the feeding action quite apart from the distance of the arc from the fusing, &c., point. Furthermore, with arc-lamps constructed with inclined electrodes the points of which do not remain at a sufficiently uniform distance apart there is difficulty in maintaining reliable regulation—for instance, a slightly-increased current, and consequently increased heating effect, would feed the carbons forward—*i. e.*, downward—and also together reducing the distance between their points, and consequently the resistance of the arc, which in its turn would again increase the current through the arc, and so on.  
 115

Sometimes it is more convenient when it is necessary to employ electrodes arranged inclined to each other to place them with their points crossing. In this way a greater inclination of the carbons can be obtained, accompanied by a smaller possible variation in the  
 125  
 130



length of the arc in the lamp. When, therefore, I construct a lamp according to my invention having electrodes inclined to each other at such a large angle as to render the lamp defective owing to the above undesirable features coming into practical effect, I provide special means, magnetically or otherwise, to keep the distance between the carbon points uniform at whatever relative position they may occupy to the feeding-stop. This is accomplished by moving one or both of the carbons nearer to or farther away from the other or each other, the regulating-gear being operated by either the main current or by a shunt, or both combined, or by other suitable means. For instance, in some cases I can arrange to keep a sufficiently uniform voltage of arc by acting on it magnetically notwithstanding the distance between the points of the carbons varying. When I employ any such arrangement, it is convenient to allow the points of the carbons to touch each other before striking the arc instead of employing a separate bridge-piece, and in this case the same mechanism may be used for striking the arc as for maintaining its uniform length or voltage.

In order that my said invention may be more easily understood and readily carried into practice, I will proceed to further describe same with reference to the drawings hereunto annexed.

Figure 1 is a view, in elevation and partly in section, of a lamp having carbons arranged parallel to each other. Fig. 2 is a view of the lamp looking in the direction of the arrow A, Fig. 1—*i. e.*, at right angles to Fig. 1. Fig. 3 is a sectional plan through line A' A', Fig. 1, looking in the direction of the arrow B. Figs. 4 and 4<sup>a</sup> are detailed drawings, showing fusible rod and stop, Fig. 4 being a view in elevation, and Fig. 4<sup>a</sup> being a vertical section on line 4 4, Fig. 4. Fig. 5 is a local view in detail, on an enlarged scale, showing the position of the carbon points, luminous arc, and glass rod during the burning of the lamp. Figs. 6, 6<sup>a</sup>, and 7 are detailed views of lamps arranged with inclined electrodes, each arrangement being hereinafter described. Figs. 8 and 8<sup>a</sup> show a pair of carbons specially disposed to each other, as hereinafter described.

Referring to Figs. 1, 2, and 3, C and C' are the two carbon holders or tubes, connected together at each end and insulated from each other. These tubes C C' are slotted at D D' throughout their length, through and in which slots, pins, or projections *d d'* pass and are guided. These pins *d d'* are fixed to the weight E, which is free to move up and down over the tubes C C', it being guided by said pins in said slots. At the lower end of the tubes C C' there are weighted levers F F', pivoted at *f f'*, (or, if desired, spring-clips,) so arranged as to clip and hold by friction the carbons G G' in the tubes. Running parallel

with the two tubes C C' there is another slotted tube H, having a longitudinal slot H', in which another pin, *h*, is guided and projects through. This pin *h* (which bears on the top end of the glass rod K in said tube H) is connected to the circular weight E, as are the pins *d d'*, which latter bear on the top end of the carbons G G'. At the lower end of this tube H a collar or stop J is provided, which is readily attached or removed from the tube H or lower part thereof—for example, by means of the bayonet-joint J'. (See Fig. 5.) A glass rod K (see Figs. 4 and 5) of about an equal length to the carbons G G' is inserted in this tube H, and the said stop J being in position normally prevents the glass rod from falling out or descending. Thus the weight E is mainly supported by its pins *h* bearing on the top of the glass rod K, while its pins *d d'* bear on the top of the carbons G G', as aforesaid. The stop J is shown in Fig. 4<sup>a</sup> in section and has a hole *j* through which the glass rod K passes and is guided. A tongue or bent portion *j'* projects under the hole *j* and acts as a stop on which the glass rod rests. A reflector L is fitted at the lower end of the tubes, and the arc *g* between the points of the carbons G G' takes place in about the position shown, or said arc may take place entirely within the reflector L. The striker M, with carbon or other conductor M', (pivoted at M<sup>2</sup>), is actuated through the connecting-rod *m* by the magnetic coil or solenoid *m'*.

In order to strike the arc, the lower points of the carbons G G' are bridged by the striker or conducting bridge-piece M', and when the current passes and the striker is automatically withdrawn the arc *g* is formed. The feeding of the carbons commences when they are burned away so as to bring the arc *g* sufficiently close to the tongue *j'* and the end of the glass rod K, whereby the lowermost part of the glass rod softens by the heat, and owing to the pressure from above exerted by the weight E the said glass rod K is slowly pressed past the tongue *j'*, which in its rigid condition was not possible, thus allowing the slow descent of the weight E, and consequently the pins *d d'* at the same time also press downward on the top of the carbons G G' and feed them down together, and so removing the arc *g* farther away from the end of the glass rod K and tongue *j'*, which movement results in the retardation of or stopping of further motion until the glass is further affected by the heat and permits further feeding action, and so on.

Figs. 4 and 4<sup>a</sup> show a large-scale view of stop J with glass rod K before the action of the heat upon it. Fig. 5 shows the stop under or after the action of the heat. The end of the glass rod K gradually melts, and from time to time drops of glass fall from it. Fig. 6 shows a modified arrangement somewhat similar to that shown in Figs. 1, 2, and 3, but having

the carbons inclined at a slight angle to each other, Fig. 6<sup>a</sup> being a cross-sectioned view on the line 6 6, Fig. 6, looking in the direction of the arrow 6, Fig. 6. In this modified arrangement the pins  $d d'$  (which bear on the top of the carbons as aforesaid) are rigidly fixed to the swinging frames or bails  $d^x$ , each of which latter is pivoted at  $d^2$  to the weight E, which latter carries the pin  $h$ , extending into the glass tube H, as aforesaid, a central aperture  $E'$  being provided in said weight of a size and shape (such as shown in Fig. 6<sup>a</sup>) to allow said weight to travel vertically throughout the length of the carbon-holder tubes C C', notwithstanding that same are inclined to each other, as shown in these figures. If desired, the tubes C C' may be slotted on both sides opposite to one another and (instead of the separate pins  $d d'$ , as shown) one single pin or horizontal bar may be employed, which would connect the two bails or swinging frames  $d^x$ , or the swinging frames could be done away with and the pin or bar connected directly to the weight E, either of these arrangements acting in a similar manner as before.

Fig. 7 illustrates another modification—namely, the inclined tubes C C' are pivoted or hinged at C<sup>2</sup> to a fixed part of the lamp-frame, while a magnetic arrangement (such as the solenoid N, attached to the tube C, and the core N', attached to the tube C') operates upon the hinged tubes C C' in such wise (when the current flows) as to swing or move said tubes so as to strike the arc, and, if desired, this magnetic arrangement may also be utilized during the burning of the lamp to vary or adjust automatically the length of the arc as occasion requires. In this view, Fig. 7, I have illustrated another modification—namely, instead of the weighted levers F F', as employed in Fig. 1 and Fig. 6, I may employ a spring F<sup>2</sup>, attached at F<sup>3</sup> to the outside of each tube C C', respectively, the lower end of each said spring F<sup>2</sup> being provided with a pin F<sup>x</sup>, which is normally kept pressed inward by the spring F<sup>2</sup> against the carbons G or G', and thus retain the latter in their normal position, this spring-pressure, however, being such as to be easily overcome by the weight E, so that as the latter is caused or allowed to descend it will push the carbons G G' downward past the spring-actuated pins F<sup>x</sup>. This spring-clip arrangement F<sup>2</sup> F<sup>x</sup>, as shown in this view, Fig. 7, may be used (in place of the weighted levers F F') in and with the other constructions of the lamp—as, for example, with parallel carbons, as shown in Fig. 1.

Figs. 8 and 8<sup>a</sup> show views at right angles of a pair of carbons with their points crossing. This disposition of the carbons may be employed for my purpose instead of having the carbons inclined toward each other, especially if no arc-regulating appliance is used, for it is possible by this arrangement of the carbons

with their points crossing to place the carbons in this manner at a much larger inclination or angle without such a great variation of arc length.

It is to be observed that in the drawings hereunto annexed, and more especially in Figs. 1 to 3, the carbons are for the sake of clearness represented farther apart than would be the case in actual practice, as in the actual construction and use of lamps of the type illustrated in Figs. 1 to 3 I find it advantageous to locate the carbons G G' at a distance apart of about one-eighth of an inch.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of fusible material, means to afford escape of that part of the fusible material which has been sufficiently acted on by the heat from the arc, means which will prevent downward movement of said fusible rod while the latter is in the rigid state, means to cause descent of the electrodes, a connection between the rigid material and the means to cause descent of the electrodes so that such descent is governed by said rigid material, guides for the electrodes, means to normally prevent the electrodes dropping out of their guides, contact-making devices to normally bear against the electrodes and convey current to the latter near their burning-points, and a guide to support the fusible material throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

2. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of glass, means to afford escape of that part of the glass rod which has been sufficiently acted on by the heat from the arc, means which will prevent downward movement of said glass rod while the latter is in a rigid state, a weight to cause descent of the electrodes, a connection between the glass rod and the weight so that such descent is governed by said glass rod, guide-tubes for the electrodes, means to normally prevent the electrodes dropping out of their guide-tubes, contact-making devices to normally bear against the electrodes and convey current to the latter near their burning-points, and a guide-tube to support the glass rod throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

3. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of fusible material, means to afford escape of that part of the fusible material which has been sufficiently acted

on by the heat from the arc, means which will prevent downward movement of said fusible rod while the latter is in the rigid state, means to cause descent of the electrodes, a connection between the rigid material and the means to cause descent of the electrodes so that such descent is governed by said rigid material, guides for the electrodes, means to normally prevent the electrodes dropping out of their guides, and a guide to support the fusible material throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

15 4. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of glass, means to afford escape of that part of the glass rod which has been sufficiently acted on by the heat from the arc, means which will prevent downward movement of said glass rod while the latter is in a rigid state, a weight to cause descent of the electrodes, a connection between the glass rod and the weight so that such descent is governed by said glass rod, guide-tubes for the electrodes, means to normally prevent the electrodes dropping out of their guide-tubes, and a guide-tube to support the glass rod throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

5 5. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of fusible material, means to afford escape of that part of the fusible material which has been sufficiently acted on by the heat from the arc, a stop such as J comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension such as  $j'$  which interposes in the path of travel of the fusible rod such as K through the tubular part of said stop, means to cause descent of the electrodes, a connection between the rigid material and the means to cause descent of the electrodes so that such descent is governed by said rigid material, guides for the electrodes, means to normally prevent the electrodes dropping out of their guides, contact-making devices to normally bear against the electrodes and convey current to the latter near their burning-points, and a guide to support the fusible material throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

60 6. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of glass, means to afford escape of that part of the glass rod which has been sufficiently acted on by the heat from

the arc, a stop such as J comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension such as  $j'$  which interposes in the path of travel of the fusible rod such as K through the tubular part of said stop, a weight to cause descent of the electrodes, a connection between the glass rod and the weight so that such descent is governed by said glass rod, guide-tubes for the electrodes, means to normally prevent the electrodes dropping out of their guide-tubes, contact-making devices to normally bear against the electrodes and convey current to the latter near their burning-points, and a guide-tube to support the glass rod throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

7. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of fusible material, means to afford escape of that part of the fusible material which has been sufficiently acted on by the heat from the arc, a stop such as J comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension such as  $j'$  which interposes in the path of travel of the fusible rod such as K through the tubular part of said stop, means to cause descent of the electrodes, a connection between the rigid material and the means to cause descent of the electrodes so that such descent is governed by said rigid material, guides for the electrodes, means to normally prevent the electrodes dropping out of their guides, and a guide to support the fusible material throughout its length in order to prevent buckling or breakage thereof, substantially as and for the purposes hereinbefore set forth.

8. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward; the combination with such electrodes of a rigid rod of glass, means to afford escape of that part of the glass rod which has been sufficiently acted on by the heat from the arc, a stop such as J comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension such as  $j'$  which interposes in the path of travel of the fusible rod such as K through the tubular part of said stop, a weight to cause descent of the electrodes, a connection between the glass rod and the weight so that such descent is governed by said glass rod, guide-tubes for the electrodes, means to normally prevent the electrodes dropping out of their guide-tubes, and a guide-tube to support the glass rod throughout its length in order to prevent buckling or breakage thereof, sub-

stantially as and for the purposes hereinbefore set forth.

9. In an electric-arc lamp wherein the electrodes are arranged with their burning-points directed downward the combination therewith of a stop such as J comprising a metal tube sleeve or socket having means at the top thereof for attaching same to the lamp and provided at its lower end with a bent tongue or extension such as *j'* which interposes in the path of travel of the fusible rod such as K

through the tubular part of said stop, substantially in the manner and for the purposes hereinbefore described with reference to and as illustrated in the drawings hereunto annexed particularly Figs. 4, 4<sup>a</sup> and 5. 15

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES OLIVER.

Witnesses:

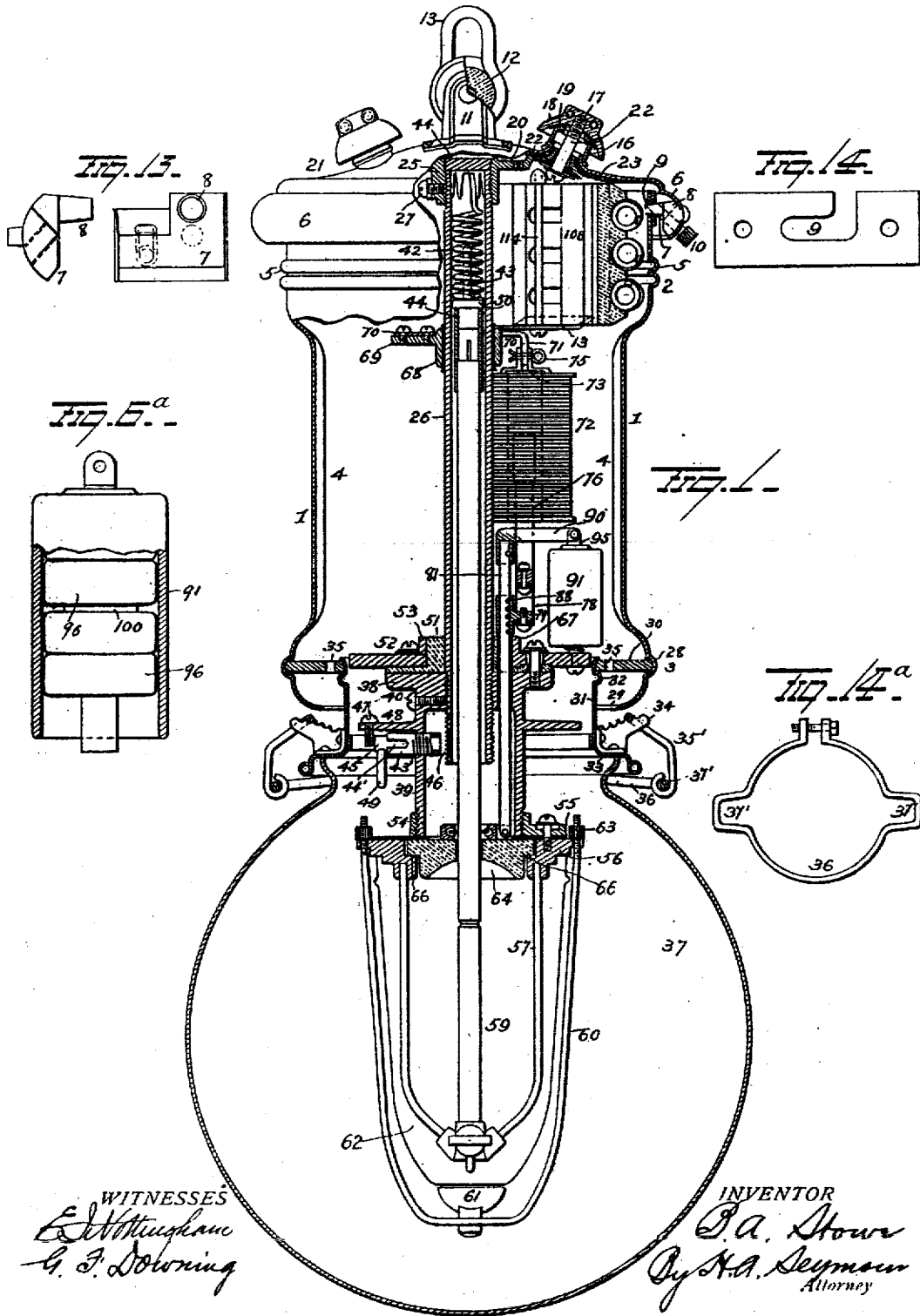
HENRY BIRKBECK,  
HERBERT D. JAMESON.

No. 796,467.

PATENTED AUG. 8, 1905.

B. A. STOWE.  
ELECTRIC ARC LAMP.  
APPLICATION FILED DEC. 5, 1902.

5 SHEETS—SHEET 1.



WITNESSES  
*E. W. Wigham*  
*G. J. Downing*

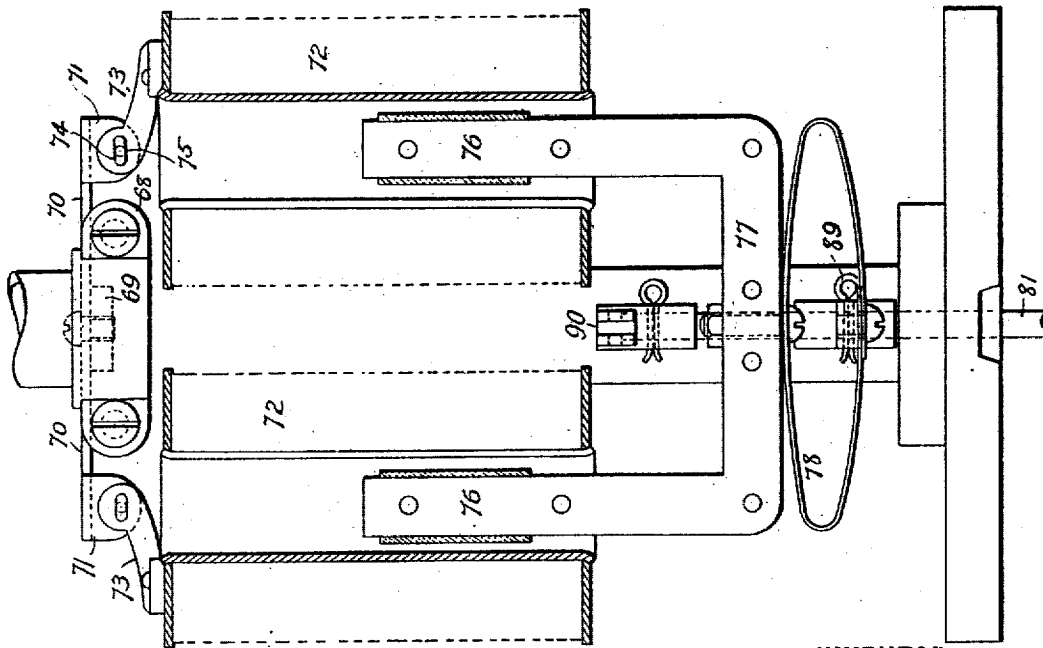
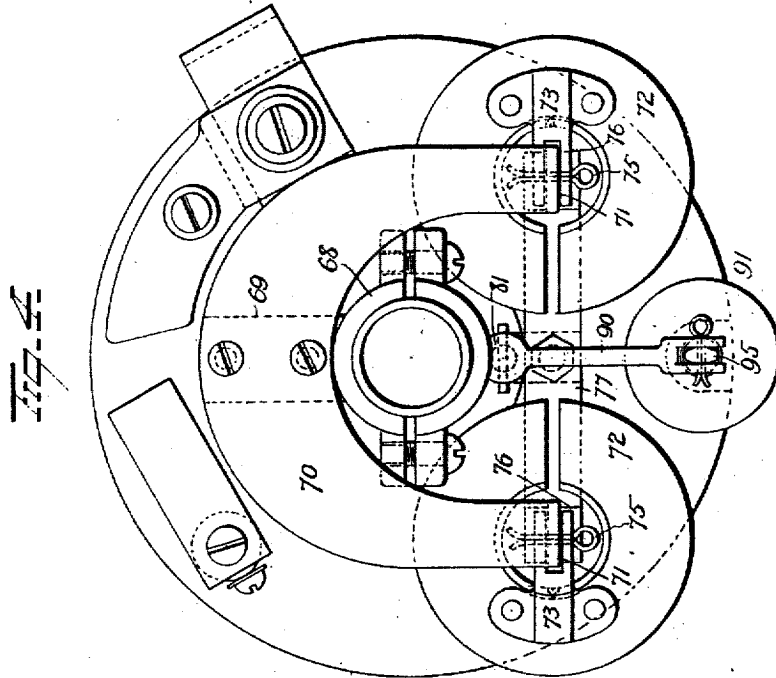
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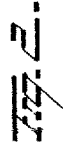
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5 SHEETS—SHEET 2.



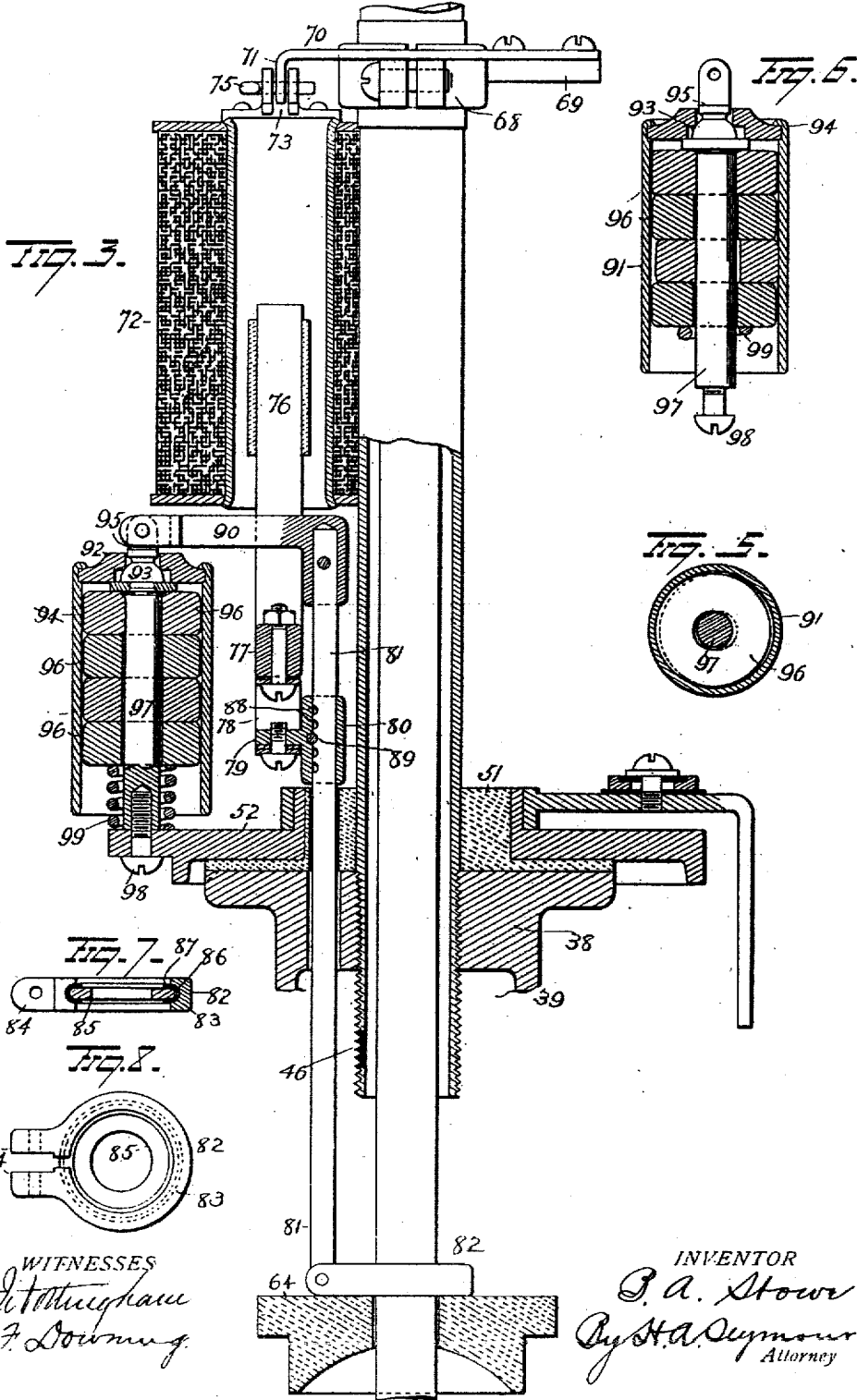
WITNESSES  
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B. A. STOWE.  
ELECTRIC ARC LAMP.  
APPLICATION FILED DEC. 5, 1902.

5 SHEETS—SHEET 3.



WITNESSES  
*E. H. Thompson*  
*C. F. Downing*

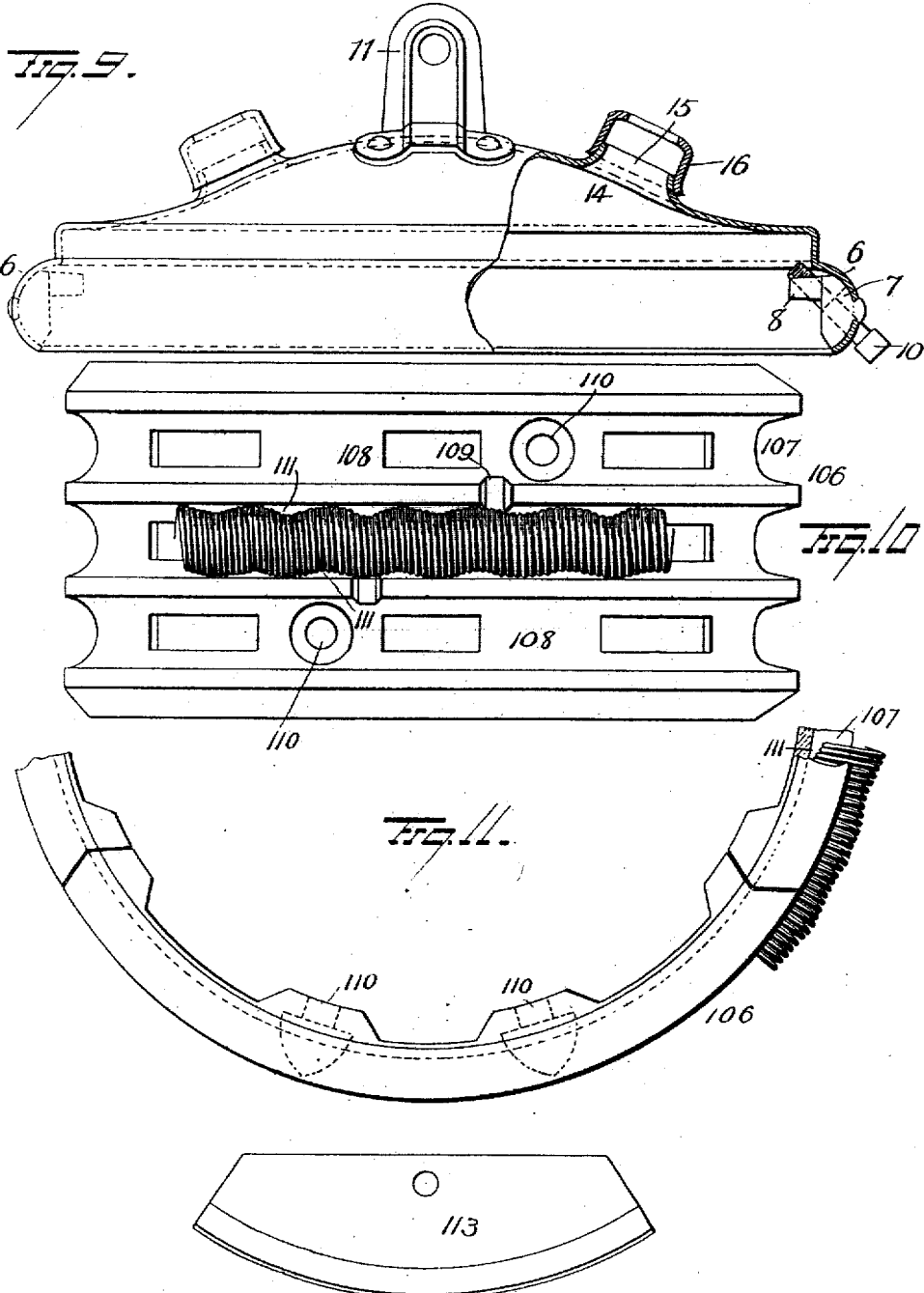
INVENTOR  
*B. A. Stowe*  
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5 SHEETS—SHEET 4.



WITNESSES  
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*G. F. Downing*

INVENTOR  
*B. A. Stowe*  
*By H. A. Seymour*  
Attorney

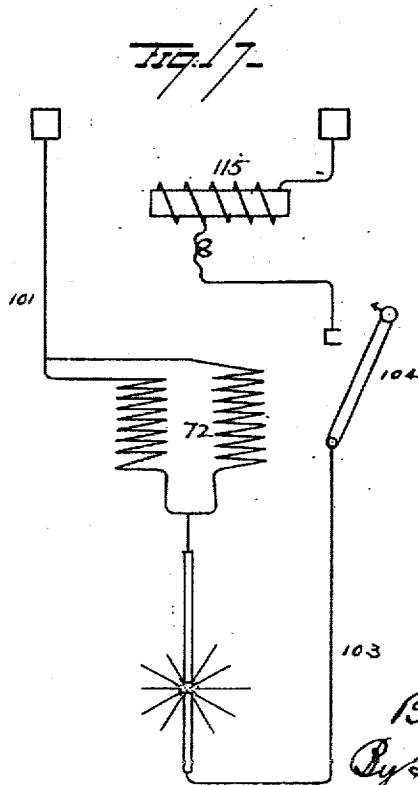
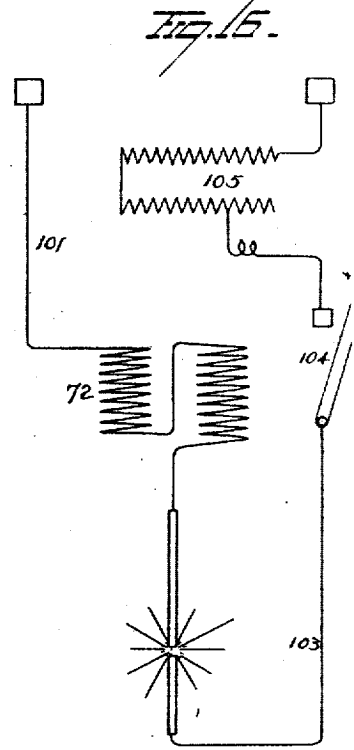
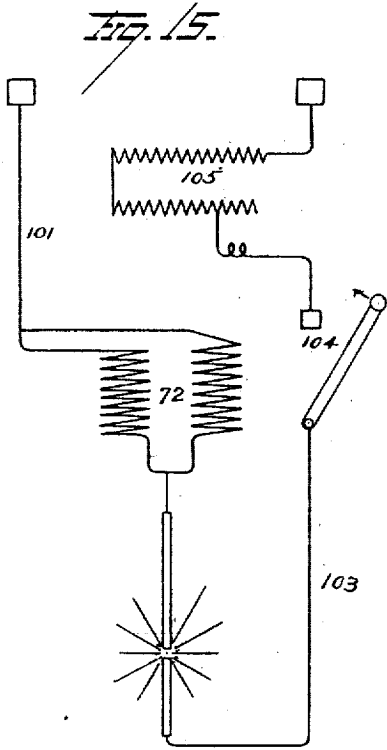


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B. A. STOWE.  
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# UNITED STATES PATENT OFFICE.

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## ELECTRIC-ARC LAMP.

No. 796,467.

Specification of Letters Patent.

Patented Aug. 8, 1905.

Application filed December 5, 1902. Serial No. 134,058.

*To all whom it may concern:*

Be it known that I, BERNARD A. STOWE, 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 improvements in electric-arc lamps, one object of the invention being to so construct the lamp that it will be readily adaptable for use on constant-potential circuits with currents of different voltage, either direct or alternating, and which can be readily converted from one type of arc-lamp to another and in accordance with the current or circuit (whether constant current or constant potential) with which it may be desired to use the lamp without altering or disturbing the general lamp structure.

A further object is to improve the lamp shell or casing and so connect it with the framework that it can be lowered bodily with the globe to expose the entire mechanism of the lamp.

A further object is to produce a general lamp structure which will admit of the removal of one regulating mechanism and the insertion of another.

A further object is to provide means to facilitate the insertion of upper carbons of different lengths into a holder within a guide-tube.

A further object is to provide a support for a resistance-coil which can be readily assembled and secured in place in the lamp structure and which can also be easily removed therefrom.

A further object is to so construct a resistance-coil as to minimize the extent of bearing-surface thereof against its support to facilitate ventilation of the coil.

A further object is to so construct and arrange a resistance-coil and its support as to insure adequate ventilation of said coil.

A further object is to provide improved controlling and regulating mechanism for an arc-lamp which can be used on constant-potential circuits of different voltage and with direct or alternating currents.

A further object is to construct and arrange the solenoids of the regulator in such manner

that accurate alinement of the cores with the bores of the spools will be insured under all conditions.

A further object is to provide simple means for adjusting the cores relatively to the coils of the solenoids according to the voltage on the circuit in which it may be desired to use the lamp.

A further object is to provide an improved air-pot for an arc-lamp-regulator mechanism.

A further object is to so construct the plunger of the air-pot as to insure the uniform action of the same.

A further object is to provide an air-pot construction in which the resistance exerted by the same to the movement of parts connected with it will not only be uniform, but can be adjusted to suit the conditions existing in a lamp of a certain type and the character of the circuit in which it is placed.

A further object is to improve the construction of an electric-arc lamp in its various details and to render it capable and efficient in the performance of all its functions.

With these objects in view the invention consists in certain 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 a sectional view of an electric-arc lamp embodying my improvements. Figs. 2 and 3 are enlarged detail views, partly in section, showing the regulator mechanism. Fig. 4 is an enlarged plan view showing the regulator mechanism. Figs. 5 and 6 are views illustrating the air-pot construction. Fig. 6<sup>a</sup> is a view illustrating the manner of adjusting the air-pot plunger. Figs. 7 and 8 are detail views of the clutch. Fig. 9 is a detail sectional view of the cap or hood of the lamp-casing. Fig. 10 is a detail view illustrating the resistance-coil and its support. Fig. 11 is a plan view illustrating a portion of the support for the resistance-coil. Figs. 12, 13, and 14 illustrate certain detail views. Figs. 15, 16, and 17 are diagrams of circuits for one hundred and ten volts, two hundred and twenty volts, and alternating-current circuits, respectively.

1 represents the main shell or body portion of the lamp-casing, having an enlarged upper portion 2 and an enlarged lower portion 3. The shell or body 1, with its enlarged ends, is constructed of a single piece of sheet metal

bent into cylindrical form and having its meeting edges permanently secured together by means of solder or otherwise. The intermediate portion of the shell is strengthened by a series of vertical corrugations 4, and the upper enlarged portion 2 is similarly strengthened by means of horizontal annular corrugations 4. A cap or hood 21 is disposed over the upper enlarged end of the shell or casing and provided with a peripheral flange 6, (preferably curved transversely,) which projects outwardly from the shell and acts as a water-shed and also to preclude the entrance of dust and dirt into the casing. At diametrically opposite points blocks 7 are secured within the curved flange 6 of the hood, and each of these blocks is provided with a lug 8. The lugs 8 enter L-shaped slots 9, located at diametrically opposite points in the upper portion 2 of the shell or casing, and are normally prevented from escape from the horizontal arms of these slots by means of a thumb-screw 10, passed upwardly through the flange 6 and entering one of the slots 9 behind the lug therein. The shell or casing is thus connected with the hood by bayonet-joints normally locked by a thumb-screw 10. A bracket 11 is secured centrally upon the hood for the reception of an insulator 12, to which a link 13 is attached for the reception of suitable suspending devices. The only openings in the top of the hood are the holes 14 for the accommodation of the binding-posts for the leading-in wires. The metal of the hood surrounding the holes 14 is pressed outwardly to form flanges 15, over which caps 16 are fitted. These caps have inwardly-turned flanges at their upper ends, and on these caps binders 17 are seated and provided with depending flanges 18 to act as water-sheds, insulating material 19 being disposed between said binders and the caps 16. A block 20, located within the upper portion of the hood 21, is provided at diametrically opposite points with perforated arms 22, seated against insulating material 23, disposed between said arms and the hood. Screw-bolts 24 are passed upwardly through the perforated arms 22 (but insulated therefrom) and enter threaded sockets in the binders 17. The central portion of the block 20 is provided with an internally-threaded enlargement 25 for the reception of the threaded upper end of a tube 26, and said tube is prevented from turning by means of a screw 27. The tube 26 receives the upper carbon of the lamp, constitutes the backbone of the lamp-frame within the casing, and supports most of the mechanism, internal structure, and inner globe, as will be more fully hereinafter explained.

Returning now to the lamp shell or casing, attention is directed to an annular bead forming an internal groove 28 in the lower enlargement 3 of the shell 1, below which bead the enlargement curves inwardly and terminates in an opening 29. A cast-metal ring

30 is seated at its periphery in the groove 28, and its internal wall is engaged by the upper end of a cylindrical shell 31, the upper edge of which is spun over the cast ring, and immediately below said ring the shell-section 31 is made with an outwardly-projecting bead 32. The ring 30 is thus secured at its inner edge to the shell-section 31 and at its periphery to the enlarged lower end 2 of the main body portion 1 of the shell or casing. The cast ring 30 is provided with holes 35 for ventilating purposes. The cylindrical shell-section 31 is provided at its lower end with a seat 33 for the outer globe, and at the juncture of said seat with the shell-section 31 notched brackets 34 are secured for the reception of the bails 35' of the globe-holder 36. The globe-holder 36 consists of a band of wire having eyes at its ends for the passage of a suitable bolt or other clamping device, and at diametrically opposite points said band is made with loops 37', with which the bails 35' have hinge connection. The globe-holder embraces the neck of the globe, and when the bails 35' are made to engage the notched brackets 34 the mouth of the globe will be held firmly against its seat.

From the construction and arrangement of parts above described it will be seen that when the upper end of the thumb-screw 10 is removed from the slot 9 in the shell or casing the latter after a slight turn can be dropped bodily, carrying also the outer globe with it and exposing the entire internal structure of the lamp. This not only gives free access to the interior of the lamp for trimming, but it also exposes the regulating mechanism, which can be readily adjusted or altered to accommodate currents of different voltage or to adapt the lamp for direct or alternating currents or even to remove one regulating mechanism and substitute another.

The lower end of the carbon-guide tube 26 extends through a threaded hole in the head 38 at the upper end of a cylinder 39, of cast metal, and projects partly through said cylinder. The cylinder and tube are prevented from turning relatively to each other by means of a screw 40 passing through the head of the cylinder and entering a hole in the tube. A movable carbon-holder 41 is located within the tube 26 and has connected with it a flexible conductor 42, which is coiled within the tube and extended from the upper end thereof for connection with the regulating mechanism of the lamp. The carbon-holder 41 is provided on its upper end with a shank 43, which abuts against the closed head 44 of the tube when a long carbon rod is forced upwardly into the carbon-holder in trimming the lamp. In some types of lamps, however, short upper carbons are used. For instance, in an alternating-current lamp an upper carbon eight or ten inches long is usually employed. It would not be convenient and, in fact, it would

be practically impossible for the trimmer to press such a short carbon up into the tube far enough to cause the shank of the carbon-holder to engage the head of the tube, and consequently a carbon of such short length could not be forced into the carbon-holder in this way. To provide for such a contingency, the devices now to be described may be employed. A tubular screw 43' is passed through the wall of the cylinder 39 and made to project into the latter. The other or plain end of the screw projects outwardly beyond the cylinder 39 and is made with an elongated slot 44'. A pin 45 is mounted to move longitudinally through the tube 43', and in alignment with this pin the carbon-tube 26 is made with a hole 46. A screw 47, projecting downwardly from a flange 48 on the cylinder, prevents the escape of the pin 45 from the tubular screw, and an arm 49 on the pin normally engages the end of the tubular screw to prevent the pin from entering the guide-tube 26. Now when it is desired to insert a short upper carbon the carbon-holder 41 is permitted to descend until the head 50 thereof has moved below the hole 46 near the lower end of the carbon-guide tube 26. The pin 45 is now turned until its arm 49 aligns with the slot 44' of the tubular screw, when the operator will press the pin forwardly and cause its end to pass through the hole 46 in the tube 26 and become disposed over the head of the carbon-holder. The trimmer can now press the carbon into the holder, the pin 45 acting as an abutment for the latter. The short carbon having thus been pressed firmly into its holder, the trimmer will withdraw the pin 45 to the position shown in Fig. 1 to permit the carbon and its holder to move a proper distance upward in the tube.

The head 38 of the cylinder 39 bears against the lower face of a flanged sleeve 51, of vulcanite or similar material, through which sleeve the carbon-guide tube also passes. An annular plate 52 is disposed upon the flange of the sleeve 51 and is made with an integral collar 53, embracing the sleeve 51. The plate 52 constitutes the clamp-floor and is secured in place by means of a series of screws passing through the plate (but insulated therefrom) and entering the flanged head 38 of the cylinder 39.

The lower end of the cylinder 39 is threaded externally for the reception of a collar 54, having lugs 55. A ring 56 is disposed below the collar and insulated therefrom, said ring being held in place by means of insulated screws passing through the lugs 55 of the collar 54 and the flange of sleeve 51 and entering said ring 56. The arms of a depending bracket 57 are secured at their upper ends to the ring 56, and said bracket is provided at its lower end with a holder 58 for the lower carbon 59. The ring 56 is provided near its periphery at diametrically opposite points

with holes for the passage of the upper ends of the arms of a depending yoke 60, the lower end of which carries a support 61 for the bottom of the arc-inclosing globe 62. The upper ends of the yoke-arms are threaded and pass freely through the holes in the ring 56, and above said ring thumb-nuts 63 are screwed on the yoke-arms, by means of which nuts the yoke can be adjusted to cause the upper end of the arc-inclosing globe to bear properly against its seat on the under face of the ring 56. Aside from the ring 56 the cover for the inner globe consists of a block 64 of porcelain or similar material having an annular flange 65 to rest upon a shoulder 66, formed in the ring 56, and also having a central hole for the passage of the upper carbon. The upper carbon passes loosely through the block 64, leaving sufficient space to permit the escape of gas from the inner globe to the cylinder 38, from which a portion of said gas may escape through a hole 67 in the cylinder-head, through which the clutch-rod passes. Air will also enter the cylinder 39 through the hole 67 and will mix with a portion of the air entering the latter from the inner globe. Now as the temperature within the inner globe rises the gas in said globe will increase in pressure and escape to the cylinder 39, where it will become diluted with air or become charged more or less with oxygen by the decomposition of the air, and when the temperature in the globe decreases (tending to produce a partial vacuum) this diluted gas will be drawn from the cylinder into the globe, these changes of temperature and consequent varying pressures within the globe being brought about by the varying intensity of the arc common in the practical operation of electric-arc lamps.

With a lamp structure such as hereinbefore described in detail various and, in fact, any form of regulating mechanism may be employed, according to the character of circuit and current with which it may be desired to use the lamp; but in this case I have shown and will describe regulating mechanism which can be employed on a constant-potential circuit with either a direct or an alternating current. A detail description of the regulating devices will now follow.

A clamp 68, constructed to be removably secured to the carbon-guide tube or backbone 26, is provided with a laterally-projecting arm 69, to which a horizontally-disposed U-shaped spring 70 is secured at the juncture of its two arms. Each arm of the spring 70 is provided at its free end with a depending lug 71, from which the spools 72 of the regulator-solenoid are pivotally suspended. To effect the free pivotal connection between the solenoid-spools 72 and the arms of the spring 70, bifurcated arms 73 are secured to the spools and terminate over the same, preferably in line with their axes. The members of the arms are provided with holes 74, and said mem-

bers receive between them the lugs 71, which depend from the arms of the spring 70, to which they are pivotally connected by means of pins 75 passing through the holes of the arms 74 and holes in the lugs 71. The cores 76 of the solenoid are made laminated and connected at their lower ends by a cross-bar 77—that is to say, each lamina is made U-shaped, so that when all the laminae are secured together a U-shaped core-frame will be produced the parallel arms of which will constitute the cores 76 and the portion connecting said parallel arms will constitute the cross-bar 77. The cross-bar of the core-frame is mounted upon the upper member of an elliptical spring 78, and the lower member of said spring is secured to a lug 79, projecting laterally from a sleeve 80. A clutch-rod 81 passes through the sleeve 80 and also through the sleeve 51 and head of cylinder 39 and is attached at its lower end to the carbon-clutch 82, disposed over the porcelain block or cover 64. This clutch is of the ring type and comprises a split ring 83, having ears 84 for the passage of a clamping-screw, and a ring 85, of steel, clamped in a groove 86 in said split ring and insulated from the latter by means of suitable insulating material 87. That portion of the clutch-rod 81 which passes through the sleeve 80 is provided with a series of notches 88, and a pin 89 passes through a hole in the sleeve 80 and through one of said notches. By these means the sleeve 80, and consequently the solenoid-cores, can be adjusted vertically relatively to the spools according to the voltage of the line on which the lamp is to be used. By pivotally suspending the spools of the solenoids and mounting the cores on a spring in the manner above explained proper operative alinement of the bores of the spools and the cores is insured during the operation of the lamp and the jar and vibration incident thereto and binding of the cores in the spools is effectually prevented, because the spools will always accommodate themselves to the cores, and vice versa. In order to avoid any possibility of the cores coming in actual contact with the wall of the bore of the spools, light and preferably soft cushioning material is placed on each core.

For the purpose of controlling the movement of the cores within the spools of the solenoids and to insure a slow and steady movement when the solenoids are acting to separate the carbons it has been common to use air-pots; but those heretofore in use have been found to be more or less defective in the accurate performance of the functions required of them. This defect is due largely to the employment of a plunger made in a single piece, which has to be made of sufficiently less diameter than the internal diameter of the cylinder to permit the passage of a limited portion of air. In view of the fact that for the reason stated the plunger was

necessarily of appreciably less diameter than that of the bore of the cylinder it has been found to be impossible to maintain said plunger concentric to the axis of the cylinder due to the jar and vibration of the mechanism of the lamp, and consequently at certain times a portion of the periphery of the single plunger will be in actual contact with the wall of the cylinder, while at a diametrically opposite point on the plunger it will be twice as far as it should be from the wall of the cylinder. Thus a duct is formed of such large size as to permit the too free flow of air, and consequently the too free movement of the plunger and in turn the too sudden movement of the regulating devices and the carbon. For the reasons above pointed out the movements of the regulating mechanism due to the imperfections of the air-pot construction heretofore in use have been spasmodic and irregular. Furthermore, with a plunger made of a single piece the relative diameters of the plunger and cylinder must be such as to leave a very small space for the passage of air between said plunger and the wall of the cylinder; otherwise the proper cushioning effect would not be obtained. It has been found in practice that the interior surface of the cylinder and the external surface of the plunger will become more or less so corroded as to interfere with the thin annular air-duct between the plunger and the wall of the cylinder and also to interfere with the proper movements of the plunger or cylinder relatively to each other. A construction is therefore desirable in which such interference by corrosion can be compensated for, and this I accomplish in a manner which will be presently explained. An arm 90 is secured to the upper end of the clutch-rod 81 and projects laterally therefrom. Below the free end of this arm the cylinder 91 of the air-pot is located, and the head 92 of this cylinder is provided on its inner face with a seat 93 for a valve 94. The shank 95 of the valve passes freely through a hole in the head 92 and is pivotally attached at its upper end to the arm 90. In this manner the cylinder of the air-pot is suspended. The plunger of the air-pot comprises a series of disks or laminae 96, constituting the plunger, and a plunger-rod 97, the latter being permanently secured at its lower end to the lamp-floor by means of a screw 98. The disks or laminae are made with alined holes for the accommodation of the plunger-rod 98, and each of these holes is of slightly but appreciably greater diameter than that of the rod 97, so that they will be capable of slight lateral movement, and the said disks or laminae each have a diameter slightly but appreciably less than that of the internal diameter of the cylinder 91. The several disks are maintained in contact with each other by means of a spring 99, encircling the rod 97 and bearing at its respective ends against the lower disk and the lamp-floor.

The upper disk of the series is secured to the plunger-rod preferably by riveting or up-setting the upper end of the rod. Now experience shows that the disks will seldom, if ever, all be concentric with the plunger-rod and the bore of the cylinder at the same time; but, as a matter of fact, they will become variously disposed and the several disks will contact with the wall of the cylinder at various points, the locus of the contacting points being approximately equal to a circle marking the inner surface of the cylinder. The effect of this will be to cause the sectional plunger to contact with the wall of the cylinder approximately throughout the entire circumference, but the disposition of the disks form a tortuous duct for the passage of air, said duct having a capacity always equal to that of an annular duct which would be formed between the peripheral walls of the disks and the wall of the cylinder if all of said disks (or a plunger consisting of a single disk) could be maintained disposed concentric to the plunger-rod and the axis of the cylinder. Thus I am enabled by the use of a plunger comprising a series of independent disks or laminae constructed and arranged as before described to insure the constant maintenance of a uniform action of the air-pot under all conditions, as well as a uniform and steady movement from one end of its throw to the other. Furthermore, I am enabled to make each disk or lamina of appreciably less diameter relatively to the internal diameter of the cylinder than would be possible with a plunger made of a single piece, because the locus of the contacting points of the several disks with the wall of the cylinder will approximately lie within a circle marked by the internal wall of the cylinder regardless of the diameter of each disk, and thus I am enabled to compensate for any interference by corrosion which would be encountered with a plunger made of a single piece, as before explained. It is apparent that if the capacity of the tortuous duct above referred to as being formed by the irregular disposition of the disks within the cylinder be increased the resistance to the movement of the cylinder relatively to the plunger will be diminished, and thus the air-pot may be adjusted to offer greater or less mechanical resistance by adjusting the capacity of the said tortuous duct. This may be accomplished by separating certain of the disks by means of a washer 100 (see Fig. 6<sup>a</sup>) of less diameter than that of the disks, the relative size of said washer to the diameter of the disks and the disposition of said washer between different pairs of disks controlling the size and capacity of the said tortuous passage from one end to the other of the series of disks. With the construction shown in the drawings the action of the solenoids will be to raise the air-pot cylinder (thus closing the valve at the upper end thereof) and cause the air-pot to

act as above explained to resist the pull of the solenoids and insure the gradual rise of the upper carbon. When the cores of the solenoids descend, the air-cushion in the cylinder will cause the valve to open, the air to escape, and the cylinder to descend quickly. It is apparent that instead of making the cylinder of the air-pot movable it may be made stationary and the plunger connected with the regulating mechanism. In such case the disposition of the air-pot structure would be the reverse to that shown in the drawings and the spring 99 dispensed with, as the disks would maintain contact with each other by gravity.

Referring now to the lamp-circuits, it may be explained that current entering the lamp will flow from the positive binding-post by a conductor 101 to the solenoids and thence from the latter by conductor 102 to the upper carbon, thence to the lower carbon, thence through a conductor 103 and a switch 104 to a resistance 105, and finally to the negative binding-post of the lamp. If the lamp is to be used on a constant-potential two-hundred-and-twenty-volt circuit, the solenoid-coils will be included in series with each other, as shown in Fig. 16; but if it is to be used on a one-hundred-and-ten-volt circuit the solenoid-coils will be included in parallel with each other, as shown in Fig. 15, the reason for this difference growing out of the fact that it is common in practice to employ five amperes on a one-hundred-and-ten-volt circuit and two and one-half amperes on a two-hundred-and-twenty-volt circuit.

I have before explained that my lamp structure is adapted for use (with the regulating mechanism herein described) on constant-potential circuits employing either direct or alternating currents, and in order to transfer the lamp from a direct-current to an alternating-current lamp it is necessary to displace the resistance-coil 105 by an inductive resistance. The resistance-coil and its support must therefore be readily removable, and I will now proceed to describe the construction and arrangement of the same and to point out certain advantageous features thereof.

The frame or support 106 for the resistance-coil consists of a series of externally-grooved segments of porcelain which when assembled make a complete ring having a series of circumferential grooves 107 for the reception of the resistance-coil. Each segment is made with slots in the bases of the grooves for ventilating purposes, and the structure of each segment is strengthened by integral cross-bars 108. The ridges between the grooves are notched, as at 109, to permit the resistance-coil to pass from one groove to another, and suitable provision is also made (such as perforated seats 110) for the attachment of binding-posts. The resistance-coil is so constructed as to minimize the extent of its

contact with the support, so as to insure the greatest possible facility for ventilation. The resistance-coil is therefore formed irregularly, so as to present the appearance of a spiral groove 111, extending from end to end thereof, said groove forming a continuous air-duct and permitting the coil to bear only at intervals against the segmental support. The segmental porcelain support for the resistance-coil is located in the enlarged upper portion 2 of the shell or casing, and each segment is disposed upon a plate 113, and said plates are secured in turn to the hood 21 by means of bolts 114. By removing these bolts the segmental support will be released, and then by removing the resistance-coil the segments can be separated and removed from the lamp without disturbing the backbone 26 or any other part of the lamp structure.

From the above description it will be seen that the resistance device is split to permit it to be placed around or removed from around the central tube without the necessity of removing the hood.

When the lamp is to be converted from a direct-current to an alternating-current lamp, it is simply necessary to remove the resistance-coil, as above explained, and insert in its place a resistance-coil 115 of any desired construction, as shown in the diagram Fig. 17.

Various slight 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.

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

1. An arc-lamp structure comprising a central tube, a hood permanently secured thereto, split resistance and reactance devices, and means for interchangeably supporting the same in place in the lamp.

2. In an electric-arc lamp, the combination with a hood and internal framework supported thereby, of a sheet-metal shell having a closed peripheral wall and means for removably connecting said shell to the hood, whereby said shell can be lowered bodily to expose the internal framework.

3. In an electric-arc lamp, the combination with a hood and internal framework supported thereby, of a sheet-metal shell removably attached to said hood, and an outer-globe holder supported by said shell.

4. In an electric-arc lamp, the combination with a hood, internal framework, regulator mechanism and an arc-inclosing globe supported by said hood, of a sheet-metal casing or shell removably attached to said hood, an outer-globe cover at the lower end of said casing or shell, and a holder for said outer globe supported by said casing or shell.

5. In an electric-arc lamp, the combination

with a hood, of a plate secured therein, binding-posts upon said hood, screws securing the binding-posts to said plate, a backbone secured to said plate, and lamp mechanism connected with said backbone.

6. In an electric-arc lamp, the combination with a hood having two holes in its top and having flanges surrounding said holes, of a plate within the hood having portions entering said holes, insulating material between said plate and hood, sleeves mounted on the flanges on the hood, caps on said sleeves, and screws passing through said plate and sleeves and entering said caps.

7. The combination in an electric-arc lamp, of a central tube having a lateral hole near its lower end, a carbon-holder and an adjustable pin adapted to enter the hole near the lower end of the tube and become disposed over the carbon-holder to facilitate the insertion of a short rod of carbon thereinto.

8. The combination in an electric-arc lamp, of a central tube having a lateral opening near its lower end, a carbon-holder in said tube, a tubular screw, means for supporting said screw in a horizontal position, a pin movable longitudinally through said tubular screw adapted to enter the hole in the central tube and become disposed over the carbon-holder therein, and means for retaining said pin in its withdrawn position.

9. The combination in an electric-arc lamp, of a central tube having a hole near its lower end, a carbon-holder in said tube, a tubular screw, means for supporting said screw in a horizontal position in line with the hole in the central tube, a longitudinally-movable pin in said tubular screw, and a stop to be engaged by the outer end of said pin.

10. The combination in an electric-arc lamp, of a central tube having a lateral hole near its lower end, a tubular screw, means for supporting said tubular screw in a horizontal position in line with the hole near the lower end of the central tube, said tubular screw having a slot in its wall, a pin movable longitudinally in said tubular screw, and an arm on said pin to normally engage the end of the screw and pass through the slot therein when said pin is moved to enter the lateral hole in the central tube.

11. In an arc-lamp, the combination with a central tube or backbone, of an annular sectional support embracing said central tube or backbone and supported by the latter, and a resistance-coil wound upon said annular sectional support.

12. The combination in an arc-lamp, of a coiled resistance-wire, and a sectional support therefor on which said resistance-wire is wound, the sections of said support being detachably connected together and to the lamp structure.

13. In an arc-lamp, the combination with the frame, and a series of plates, of a resistance-

supporting device comprising several removable segments mounted, respectively, on said plates, bolts securing said plates to the frame and a resistance-wire wound on said segments.

14. In an arc-lamp, the combination with the central tube or backbone and a plate secured to the upper end thereof, of a series of plates disposed below said first-mentioned plate, a segmental ring of insulating material having its segments mounted on the series of plates, and removable bolts securing the said series of plates to the plate secured to the central tube or backbone of the lamp.

15. In an arc-lamp, the combination with a regulator-magnet and a clutch, of a connecting device between the regulator-magnet and the clutch, a retarding device comprising a cylinder and a plunger consisting of a series of independent sections, one of said parts of the retarding device attached to a fixed support and the other part attached to the said connecting device.

16. In an arc-lamp, the combination with a clutch-rod and a regulator-magnet connected therewith, of an arm projecting laterally from said clutch-rod, an air-pot cylinder, a valve in the upper end thereof connected with and suspended from said arm, a plunger in said cylinder, and a fixed support for the plunger-rod of said plunger.

17. In an arc-lamp, the combination with a clutch-rod and a regulator-magnet connected with said rod, of an arm projecting laterally from said rod, an air-pot cylinder, a valve in the upper end of said cylinder attached to and suspended from said arm, a plunger-rod, and a plunger on said rod comprising several independent laterally-movable disks, a fixed support for said plunger-rod and a spring between the lower disk of the series and said fixed support.

18. A clutch for an arc-lamp, comprising an annular frame having an internal annular groove, ears projecting from the meeting ends of said frame, a ring disposed within the grooved frame, insulating material between said ring and frame and a fastening device passing through the ears of the frame.

19. In an electric-arc lamp, the combination with regulator-magnets and their cores or armatures, of a clutch, a clutch-rod, a connection between the cores or armatures of the regulator-magnets and the clutch-rod, an air-pot cylinder suspended from said clutch-rod, a plunger comprising independently-movable disks in said air-pot cylinder, a plunger-rod on which said disks are loosely mounted and a fixed support for said plunger-rod.

20. In an electric-arc lamp, the combination with a central tube or backbone, of a clamp secured thereto, a spring-plate secured to said clamp and regulator-magnets secured to the free ends of said spring-plate.

21. In an electric-arc lamp, the combination with a central tube or backbone, of a U-shaped spring-plate embracing said central tube or backbone, and regulator-magnets suspended from the free ends of said spring-plate.

22. In an electric-arc lamp, the combination with a central tube or backbone and arms projecting laterally therefrom, of helices pivotally attached to and suspended from said arms, a yielding supported core-frame and sleeves of soft material on the arms of said core-frame.

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

BERNARD A. STOWE.

Witnesses:

ROBERT F. LAGANKE,  
FRANK A. ROGERS.



E. VIALE.  
ELECTRIC ARC LAMP.  
APPLICATION FILED JUNE 16, 1904.

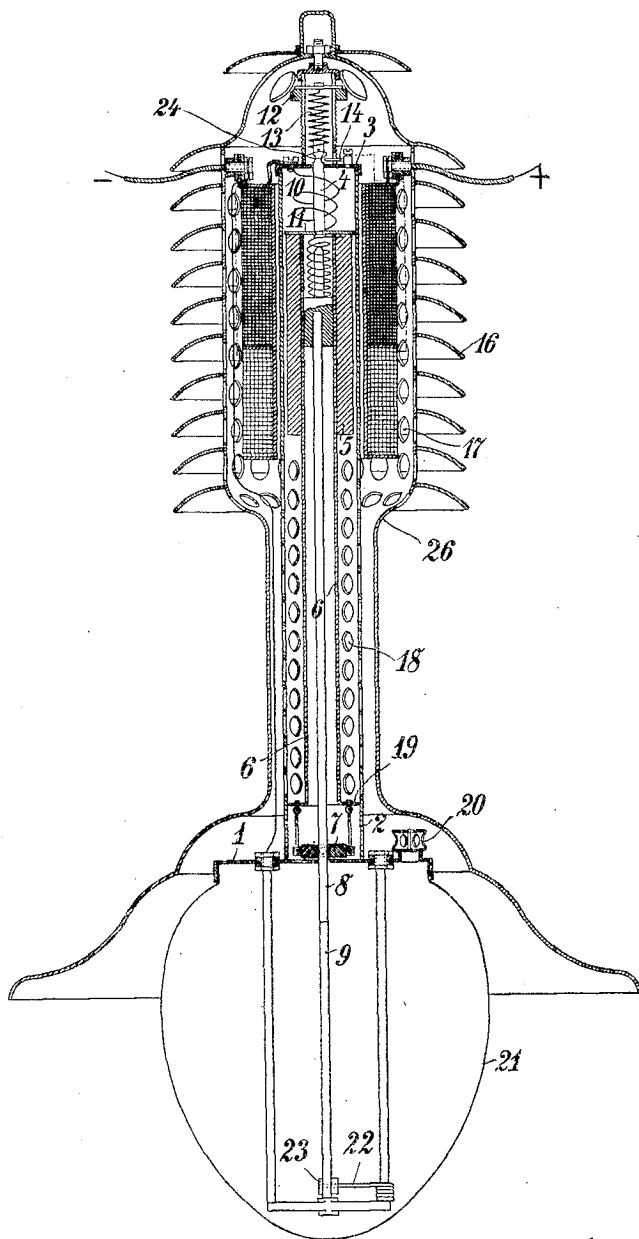


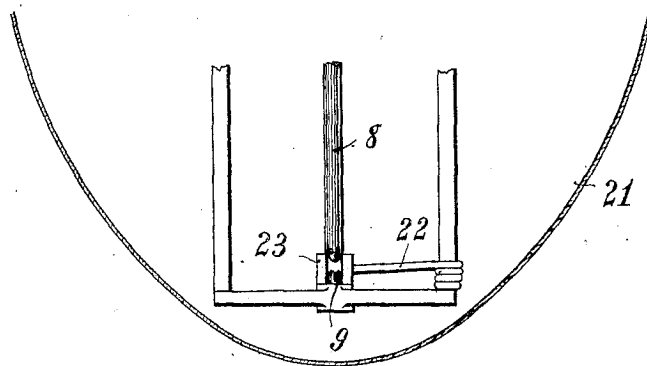
Fig. 1.

Witnesses:  
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Laura MacMorris

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ELECTRIC ARC LAMP.  
APPLICATION FILED JUNE 16, 1904.

Fig. 2.



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# UNITED STATES PATENT OFFICE.

EGIDIO VIALE, OF GROSS-LICHTERFELDE, NEAR BERLIN, GERMANY.

## ELECTRIC-ARC LAMP.

No. 801,939.

Specification of Letters Patent.

Patented Oct. 17, 1905.

Application filed June 16, 1904. Serial No. 212,874.

*To all whom it may concern:*

Be it known that I, EGIDIO VIALE, a subject of the King of Italy, and a resident of Gross-Lichterfelde, near Berlin, in the Kingdom of Prussia, Germany, have invented a certain new and useful Improvement 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, reference being had to the accompanying drawings, and to numerals of reference marked thereon, which form a part of this specification.

My invention relates to improvements in electric-arc lamps.

The existing forms of lamps, more especially the smaller types and those burning continuously, are, as is well known, exposed to the injurious influence of the heat generated by the arc, this being further heightened by the lack of a sufficient circulation of air, so that very high temperatures are produced. It is, however, impossible without further precautions to enlarge any apertures that may be made in the head of the lamp beyond a certain size, as otherwise the parts of the lamp within the head would be exposed to the action of the weather.

The present invention is based on the consideration that it is essential to arrange the various regulating parts of the lamp as far as possible away from the electric arc and, furthermore, to construct them in the simplest possible manner, providing at the same time for a circulation of air and for the arrangement of devices for facilitating the radiation of heat.

Figure 1 of the drawings shows a sectional elevation of a lamp according to this invention, and Fig. 2 a detail of the incombustible clutch.

A tube 2, concentrically arranged on a base-plate 1, has its upper end closed by a cover 3, through the center of which passes a spindle 4, which, in conjunction with the iron core 5, a guide-tube 6, and a clamp or clutch 7, constitutes the principal movable regulating parts of the lamp and which with the attraction of one or more solenoids effect the formation and maintenance of the electric arc between the electrodes 8 and 9 and at the same time serve as a brake by the compression and drawing in of the air in the chamber 10, formed by the parts mentioned, such braking effect being produced by means of the core-carry-

ing plate 11, which acts as a piston, and a spring 13, attached to and surrounding the spindle 4, by the manipulation of which spring 13 through a screw 12 greater or less resistance, as desired, is offered to the braking action of the core-carrying plate 11. This arrangement obviates in a simple manner the necessity for providing a separate air-brake, since the same parts act both as a brake and as a regulator of the tension and length of the arc. In the case of differential or shunt lamps it performs the third function of automatically breaking circuit for the fine-wire solenoid, the action of the piston drawing the spindle 4 down until the recess 24 is brought level with the flexible contact 14, and consequently the latter is put out of contact with the said spindle 4, thus interrupting the current.

By turning a screw 12 the tension of the counter-spring 13 can be modified in such a manner that by means of the mechanical effect of the spring in conjunction with the magnetic influence of the solenoids the lamp can be regulated, while by means of the flexible contact 14, mounted on the insulated positive clamp of the shunt-solenoid and pressing lightly on the rod 4 while the lamp is burning, the current in the solenoid can be automatically cut off should the lamp go out from any cause. This is effected by the attraction of the solenoid, which tends to draw the regulating device consisting of the parts 4 5 6 7 downward.

As all the parts are mounted concentrically in the highest parts of the lamp and are constructed to fit very close together, it follows that the arrangement of same is itself sufficient to obviate the inconveniences of friction and jamming caused by the injurious influence of the heat, the latter being in addition radiated outward by the arrangement of the gills 16. These gills at the same time protect the interior of the lamp from the injurious effects of the weather and also by the orifices 17 in the casing 26, carrying such gills, of facilitating the production of a very powerful circulation of air. The same purpose is effected by the orifices 18 in the pipe 2, which permit the circulation of air around the regulating device without prejudice to the breaking action and without admitting air into the globe of continuous-burning arc-lamps. In this latter case the access of air into the globe is prevented in any position by the plate 19, carrying the clamp or clutch 7, without the necessity for providing an air-tight joint for the

pipe 2. The heated air and gases produced within the lamp-globe 21 make their escape through the valve 20.

In order to prevent contact between the positive electrode and the carrier of the negative electrode in the event of the latter electrode burning at an excessively rapid rate, a spring 22 is provided with an incombustible clutch 23, which at the instant the electrode is consumed, and the resistance preventing the movement of the spring is consequently removed, effects the interruption of the electric arc, inasmuch as the incombustible clutch then rests upon the carrier of the negative electrode.

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

1. In an arc-lamp, the combination with the solenoid-core and the upper carbon controlled thereby, of an air-clutch chamber formed above the solenoid-core and in which the solenoid works as a plunger, so that an air-clutch is formed to break the descent of the upper carbon, a spindle extending upwardly from the solenoid-core, a spring connected at one end to the spindle, and an adjusting-screw connected to the other end of the spring.

2. In an arc-lamp, the combination of a tube formed with an air-clutch chamber at its upper end, a solenoid-coil surrounding the tube, a solenoid-core working in the tube, a plate closing the upper end of the solenoid and working tightly within the tube, a spindle extending upwardly from the plate, a spring connected at one end to the spindle, an adjusting-screw connected to the other end of the spring, and the upper carbon controlled by the core.

3. In an arc-lamp, the combination of a tube perforated intermediate its ends, a solenoid-coil surrounding the upper end of the tube, a solenoid-core movable within the tube, a guide-tube suspended from the solenoid-core, a globe top plate supported from the perforated tube and provided with a carbon-opening, and means for supporting a carbon within the guide-tube and through the opening in the globe top plate.

4. In an arc-lamp, the combination of a tube perforated intermediate its ends, a solenoid-coil surrounding the upper end of the tube, a solenoid-core movable within the tube, a guide-tube suspended from the solenoid-core, a globe top plate supported from the perforated tube and provided with a carbon-opening, and a clutch depending from the guide-tube and supporting the carbon in the guide-tube and through the opening in the globe top plate.

5. In an arc-lamp, the combination of a tube perforated intermediate its ends, a solenoid-coil surrounding the upper end of the tube, a solenoid-core movable within the tube, a guide-tube suspended from the solenoid-core, a globe top plate supported from the perforated tube and provided with a carbon-opening, a clutch depending from the guide-tube and supporting the carbon in the guide-tube and through the opening in the globe top plate, and means within the perforated tube and surrounding the guide-tube to prevent access of air to the globe through the carbon-opening.

6. In an arc-lamp, the combination of a tube perforated intermediate its ends, a solenoid-coil surrounding the upper end of the tube, a solenoid-core movable within the tube, a guide-tube suspended from the solenoid-core, a globe top plate supported from the perforated tube and provided with a carbon-opening, a clutch depending from the guide-tube and supporting the carbon in the guide-tube and through the opening in the globe top plate, and a plate carried by the guide-tube and working within the perforated tube to prevent the entrance of air through the carbon-opening into the globe.

7. In an arc-lamp, the combination of a tube formed with an air-chamber at its top and perforated below said air-chamber, a solenoid-coil surrounding the tube, a solenoid-core working tightly within the tube, a guide-tube depending from the solenoid-core, a globe top plate secured to the lower end of the perforated tube and provided with a carbon-opening, and means for supporting a carbon within the guide-tube and through the carbon-opening.

8. In an arc-lamp, the combination of a tube formed with an air-chamber at its top and perforated below said air-chamber, a solenoid-coil surrounding the tube, a solenoid-core working tightly within the tube, a guide-tube depending from the solenoid-core, a globe top plate secured to the lower end of the perforated tube and provided with a carbon-opening, means for supporting a carbon within the guide-tube and through the carbon-opening, and a plate carried by the guide-tube and working within the perforated tube to prevent the entrance of air through the carbon-opening into the globe.

9. In an arc-lamp, a means for preventing the contact between the positive electrode and the carrier of the negative electrode, comprising a spring, and an incombustible clutch moved by the spring, when the negative electrode is consumed, to a position between the positive electrode and the negative carrier.

10. In an arc-lamp, the combination of the solenoid-coil having a shunt-circuit, a solenoid-core, means carried by the core and forming one contact of the shunt-circuit, and another contact of the shunt-circuit in the path of the contact on the core, the two contacts being in engagement when the lamp is burning and out of engagement when the lamp is out.

11. In an arc-lamp the combination of the

solenoid-coil having a shunt-circuit, a solenoid-core, a rod carried by the upper end of the core and forming a contact of the shunt-circuit, and a spring forming another contact of the shunt-circuit, positioned above the core in the path of the rod so that when the core drops, it carries the rod out of contact with the spring to interrupt the shunt-circuit.

10 12. In an arc-lamp, the combination of a hollow solenoid-core closed at its upper end, a guide-tube secured in the lower end of the hollow core, a carbon-holder mounted in the guide-tube, an iron rod extending upwardly from the closed end of the core, a spring secured at one end to the iron rod, and means for regulating the tension of the spring.

15 13. In an arc-lamp, the combination of a hollow solenoid-core closed at its upper end, an air-clutch chamber located above the upper end of the core, a guide-tube secured in the lower end of the hollow core, a carbon-holder

mounted in the guide-tube, an iron rod extending upwardly from the closed end of the core, a spring secured at one end to the iron rod, and means for regulating the tension of the spring.

14. In an arc-lamp, the combination of the perforated tube, a solenoid-core surrounding the upper end of the tube, regulating mechanism mounted within the perforated tube, and an outer tube concentrically surrounding the perforated tube, having a restricted portion near its lower end, a perforated portion and dome-shaped flanges surrounding the perforated portion.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

EGIDIO VIALE.

Witnesses:

WOLDEMAR HAUPT,  
HENRY HASPER.

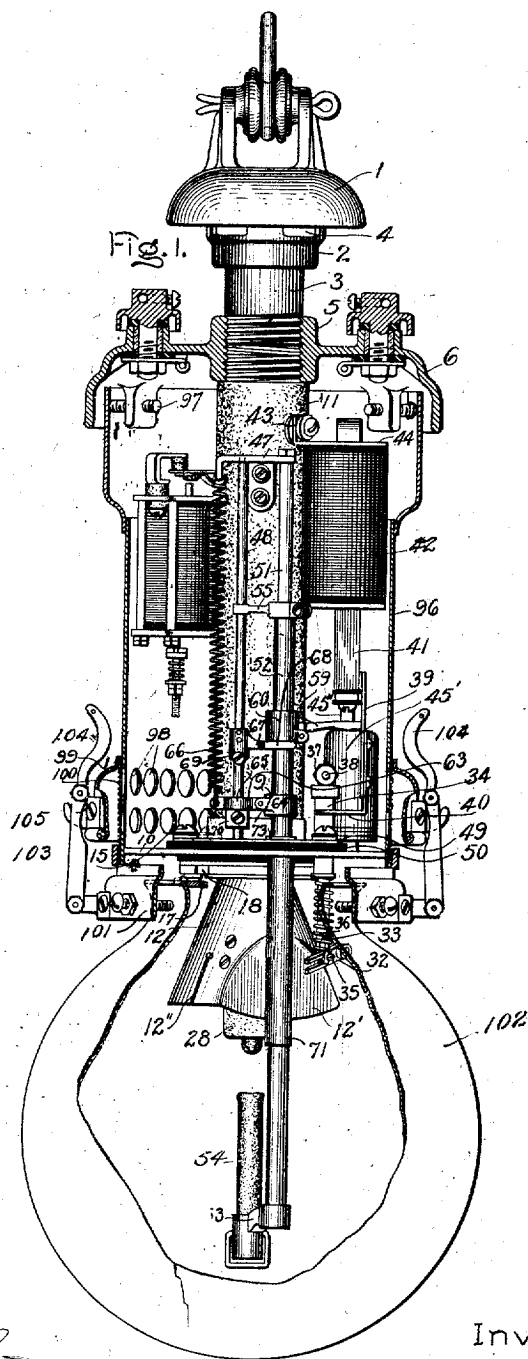
No. 885,338.

PATENTED APR. 21, 1908.

J. HÄRDÉN.  
ARC LAMP.

APPLICATION FILED DEC. 12, 1903.

2 SHEETS—SHEET 1.



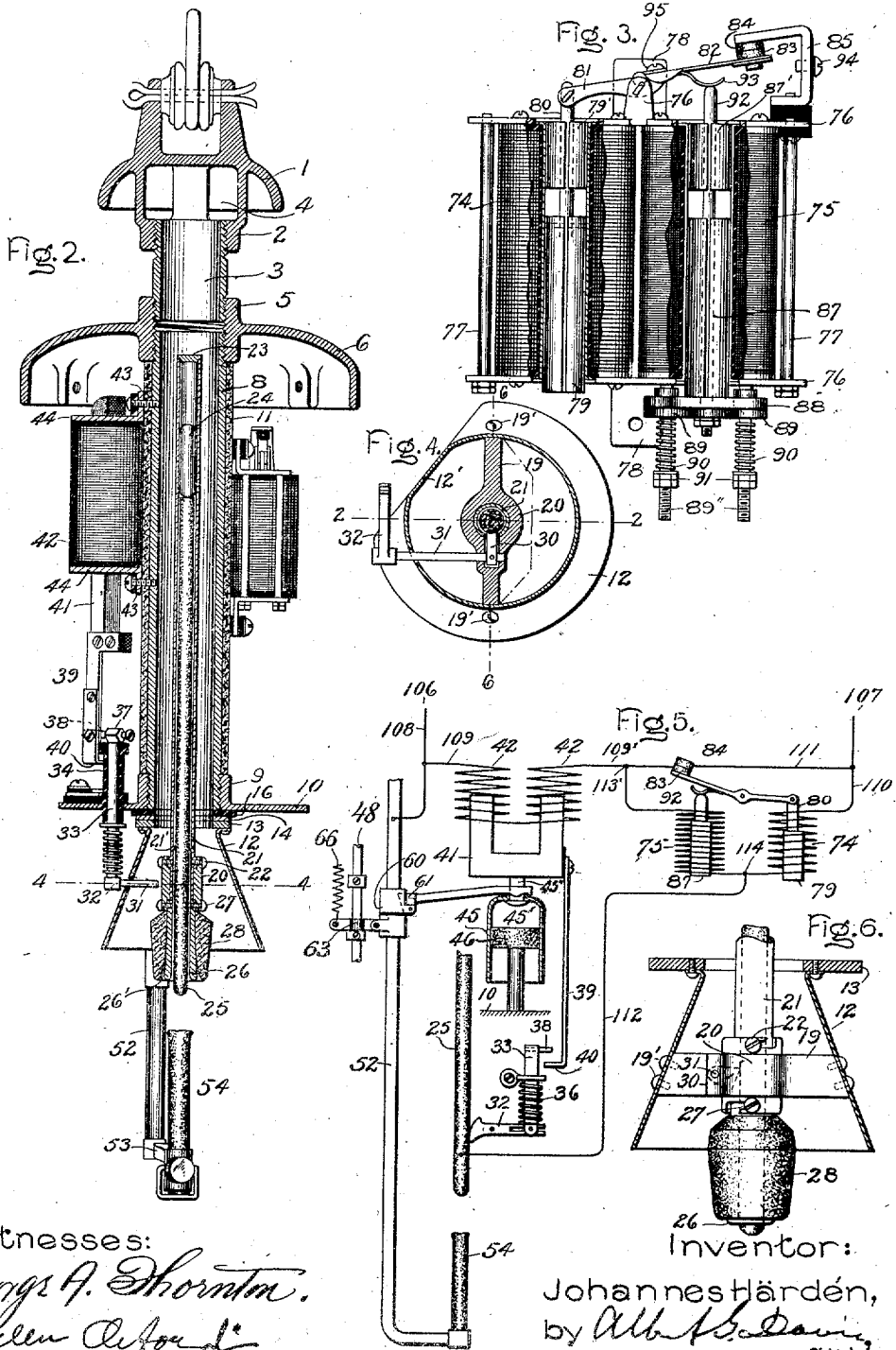
Witnesses:  
*George A. Sherman.*  
*Helen A. Ford*

Inventor  
Johannes Härdén,  
by *Albert H. Davis*  
Att'y.

J. HÄRDÉN.  
ARC LAMP.

APPLICATION FILED DEC. 12, 1903.

2 SHEETS—SHEET 2.



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Inventor:  
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 ATTORNEY.

# UNITED STATES PATENT OFFICE.

JOHANNES HÄRDÉN, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 885,338.

Specification of Letters Patent.

Patented April 21, 1908.

Application filed December 12, 1903. Serial No. 184,876.

*To all whom it may concern:*

Be it known that I, JOHANNES HÄRDÉN, a subject of the King of Norway and Sweden, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

The object of my present invention is the improvement of arc lamps. More particularly my present invention relates to alternating current arc lamps in which the major portion of the illumination from the lamp is given by a flaming or luminous arc, as distinguished from those in which practically all of the illumination comes from electrodes heated to incandescence. With the electrodes employed in these lamps the products of combustion from the arc are not all permanent gases, as is substantially the case where carbon electrodes are employed, but contain matter which condenses to solid form. This necessitates a lamp arranged so that the solid matter cannot be deposited where it will clog up or otherwise hurt the operation of the lamp.

Satisfactory electrodes giving a flaming or luminous arc have been heretofore employed in direct current arc lamps, and are but very slowly consumed in air at the temperatures attained by them in operation. For use in alternating current lamps, however, it has been found desirable to employ in one of the electrodes, at least, a composition which rapidly wastes away in air at the temperature attained by it. I have devised means, therefore, for protecting this electrode of the lamp from combustion.

The lamp which I have hereinafter described and illustrated in detail is characterized by many novel features, all of which will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing, in which I have illustrated one embodiment of it.

Of the drawings, Figure 1 is an elevation with the casing and part of the mechanism in section and the globe broken away; Fig. 2 is a sectional elevation of the lamp on the line 2 2 of Fig. 4; Fig. 3 is an elevation showing the feeding coils; Fig. 4 is a section taken on the line 4 4 of Fig. 2; Fig. 5 is a diagram illus-

trating the circuits of the lamp; and Fig. 6 is a partial sectional elevation taken on the line 6 6 of Fig. 4.

Referring to the drawing, 1 represents a lamp cap or top on the upper side of which suitable means are provided by which the lamp may be suspended. From the under side of the cap or top 1 an integrally-formed tubular boss 2 depends. This boss is threaded interiorly to receive the threaded upper end of a short metal tube 3, as is clearly shown in Figs. 1 and 2 of the drawings. The boss 2 has a series of apertures 4 formed in it. The lower end of the tube 3 is also threaded to engage the upper end of the interiorly threaded cylinder 5 extending through and integrally connected to a circular member 6. The upper end of a section of metal tube 8 is threaded into the lower end of the cylinder 5. The section 8, which is similar to section 3 except that it is considerably longer, is also threaded at its lower ends to engage an interiorly threaded tubular boss 9, projecting upward from the disk-shaped platform 10. The section 8 is surrounded by a layer 11 of material which is an insulator both of heat and electricity.

A hollow member 12, in the form of the frustum of a cone, preferably formed of sheet copper, is secured to the under side of the platform 10 and extends in line and in open communication with the sections 3 and 8. In the construction shown in the drawings the upper and smaller end of the member 12 is secured to an annular member 13 which abuts against a metallic washer 14 secured to the platform 10 by a pair of screws 15. The screws 15 are insulated from the platform 10, in any suitable manner, and a layer 16 of insulating material is interposed between the washer 14 and the under side of the platform 10. Clamping nuts 17 on the end of the screws 15 are employed for holding the annular member 13 against the washer 14 and the platform 10. Preferably open-ended slots 18 are formed in the flange 13 through which the screws pass. This facilitates a ready removal of the member 12 from the platform 10 whenever it becomes desirable. With the construction employed it will be seen that the member 12 is secured to the platform 10 but is at the same time insulated therefrom. One side of the conical member 12 is flattened, as indicated at 12', to obtain sufficient clearance for the elec-

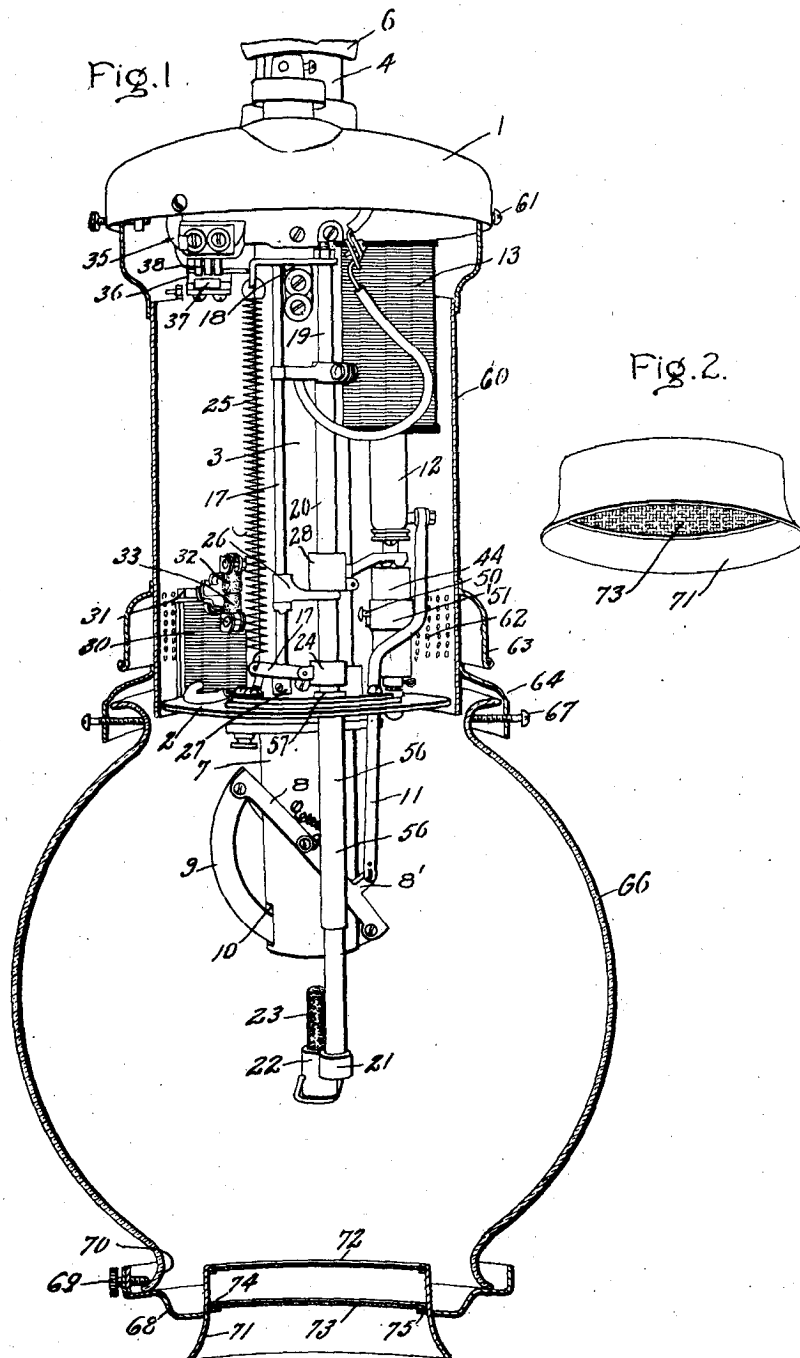


W. S. WEEDON.

ARC LAMP.

APPLICATION FILED MAY 20, 1904.

2 SHEETS—SHEET 1.



Witnesses:

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Inventor:

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*Albert S. Davis*  
by  
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W. S. WEEDON.  
ARC LAMP.

APPLICATION FILED MAY 20, 1904.

2 SHEETS—SHEET 2.

Fig. 3.

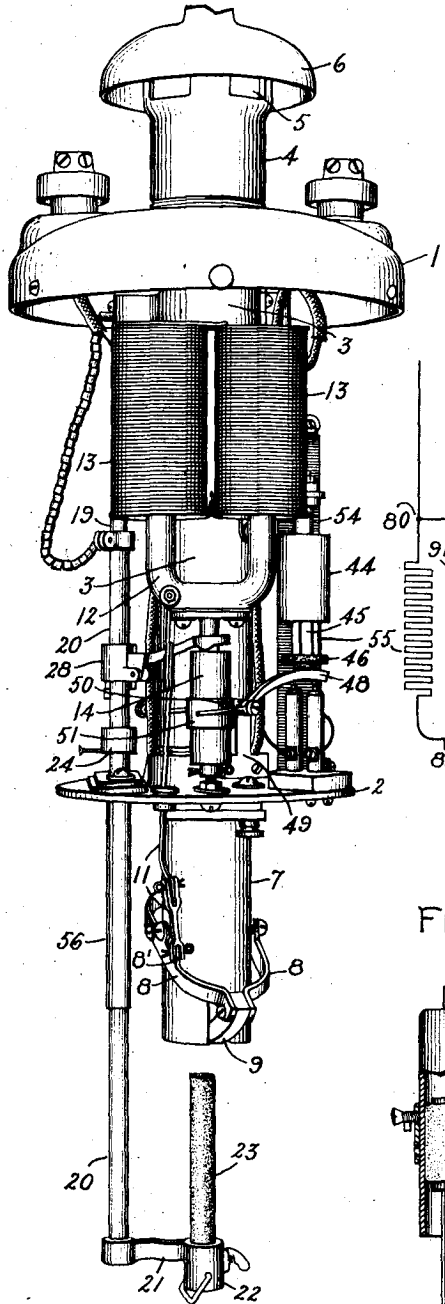


Fig. 4.

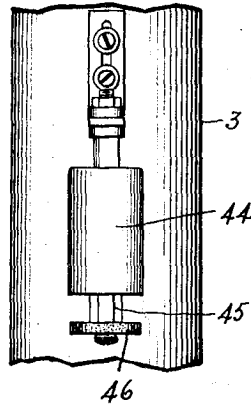


Fig. 5.

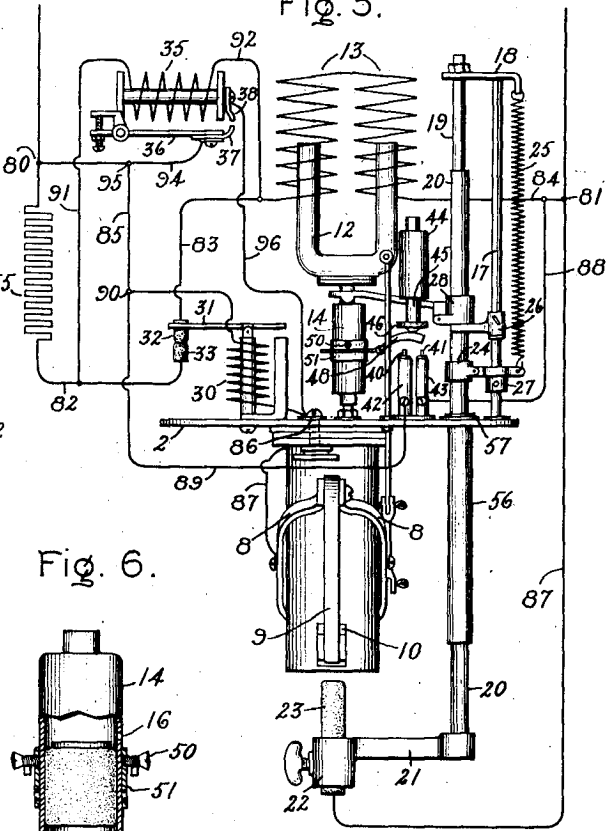
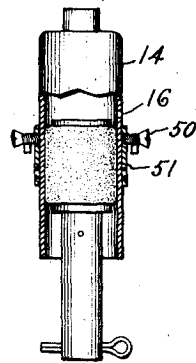


Fig. 6.



Witnesses:

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*Helen Arford*

Inventor:

William S. Weedon,  
by *Albert S. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

WILLIAM S. WEEDON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 889,162.

Specification of Letters Patent.

Patented May 26, 1908.

Application filed May 20, 1904. Serial No. 208,923.

*To all whom it may concern:*

Be it known that I, WILLIAM S. WEEDON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention relates to arc lamps, more particularly to that type in which the electrodes employed insure a flaming or luminous arc, though all of the features of my invention are not limited to use with such electrodes.

My present invention has for its object the provision of an improved feeding mechanism for arc lamps particularly of the character above specified, and an arrangement whereby a suitable draft through the lamp can be obtained.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be made to the accompanying description and drawings in which I have illustrated and described one embodiment of my invention.

Of the drawings, Figure 1 is an elevation of an arc lamp equipped with my invention with parts broken away and in section; Fig. 2 is a perspective view showing a portion of the air screen; Fig. 3 is an elevation of the lamp with the casing and globe removed; Fig. 4 is an elevation showing a detail construction; Fig. 5 is a diagram illustrating the circuit arrangement of the lamp, and Fig. 6 is a sectional elevation showing the construction of the main dashpot.

Referring to the drawings, 1 represents the upper cap or top member of the lamp proper. A disk shaped platform 2 is connected to the cap 1 by a tubular member 3. A tubular member 4 in line with the tubular member 3 extends a short distance above the cap 1. Lateral openings 5 in the wall of the member 4 at its upper end are shielded by a hood 6 carried at the upper end of the member 4. Suitable provisions, not shown in the drawings, may be provided for engaging the hood member 6 to support the lamp. The members 3 and 4 may be integral with each other but are preferably separable and may be secured to the cap member 1 by a threaded connection. Similarly the platform 2 may be

supported from the lower end of the member 3 by a threaded connection.

A tubular member 7 in line and in open communication with the members 3 and 4 is secured to but insulated from the under side of the platform 2. Bowed members 8 pivotally secured to opposite sides of the tubular member 7 have clamped between their ends the ends of an arc shaped bar 9 which forms the positive electrode of the lamp. The bar 9 is formed of some material such as wrought copper which is a good conductor of heat and electricity and is not readily oxidized at the temperature to which it is subjected. Slots 10 are formed in opposite sides of the member 7 at its lower end to admit the passage through the member 7 of the bar 9.

A projection 8' from one of the bowed members is connected by links or bars 11 to a U shaped armature 12 which with its cooperating solenoid coils 13 is located between the cap 1 and the platform 2. The coils 13 are secured to and carried by the tubular member 3. To the under side of the armature 12 is secured the outer shell member of a dashpot 14. The piston member of the dashpot is secured to the platform 2. The shell member of the dashpot 14 is formed with a lateral opening or passage 16 as shown in Fig. 6, whereby an initial downward movement of the armature 12 will not be opposed by the dashpot, this opening serving as a vent or escape passage. After a movement of the armature in the downward direction sufficient to cause the piston member to close the passage 16 a further downward movement of the armature will be delayed by the dashpot. The dashpot is so constructed as to offer no opposition to a rapid upward movement of the armature.

The lower end of a post 17 is secured to the platform 2 and extends parallel to member 3. The upper end of the post is connected to the member 3 near its upper end by a bracket 18. A guide rod 19 the upper end of which is secured to the bracket 18 extends parallel to it to a point adjacent the platform. A tubular member 20 passing through an aperture formed for the purpose in the platform 2 slides on the guide rod 19. An arm 21 secured to the lower end of the tubular member 20 carries a socket 22 at its free end in which the negative electrode 23 of the lamp is held in line with the axis of the tubular member 7. The electrode 23 is formed of or contains

some material such for instance as magnetite, titanium oxid or their mixtures, titanium carbid or the like, which in consuming gives a flaming or luminous arc.

5 The yoke of a clutch member 24 surrounds the tubular member 20. The pawl of the clutch member 24 is apertured to receive the post 17 which serves as a guide to prevent angular displacement of the clutch 24. A  
10 helical spring 25 one end of which is secured to the free end of the pawl of the clutch 24 normally holds the pawl in the position in which it locks the clutch 24 and the tubular member 20 together. Adjustable stops 26 and 27 secured  
15 to the post 17 limit the upward and downward movement respectively of the clutch 24. The yoke member of a clutch 28 surrounds the tubular member 20 above the clutch 24. The outer end of the pawl of the  
20 clutch 28 is apertured to receive the stem connecting the shell of the dashpot member 14 to the armature 12.

When the coils 13 are energized in a manner hereinafter described, the armature 12  
25 will be raised. When the armature 12 is raised the outer end of the pawl member of the clutch 28 is first elevated to lock the tubular member 20 to the clutch 28 after which the tubular member 20 and electrode 23 will  
30 move forward with the armature. At the same time the electrode 9 will be oscillated by the links 11. The upward movement of the electrode 23 will be continued in the normal operation of the lamp until its upper end  
35 impinges against the under side of the electrode 9. The clutch member 24 will move upward with the tubular member 20 until its pawl strikes the under side of the stop 26, after which further upward movement of the  
40 tubular member 20 will take place without corresponding upward movement of the clutch 24, the member 20 being pulled thereafter through the yoke of the clutch member 24. In the normal position of the lamp  
45 shown in Figs. 1 and 3 the yoke of the clutch member 28 rests upon an extension from the stop 26, and the member 20 is not locked to the clutch 28.

A series coil 30 is supported by the platform 2. The movable pivoted armature 31  
50 cooperating with this coil carries a contact 32 which engages a contact 33 when the winding 30 is deenergized. When the winding 30 is energized, however, the armature 31 is  
55 oscillated and the contacts 32 and 33 are held separated.

A shunt coil 35 is secured to the member 3 near its upper end. The movable armature  
60 36 cooperating with this coil carries a contact 37 which is out of engagement with a fixed contact 38 when the coil 35 is not operatively energized. When the coil 35 is operatively energized, however, the contact 37 is moved into engagement with the contact 38.

65 A pair of contact devices 40 and 41 are

carried by and project from the upper ends of a pair of posts 42 and 43 respectively which extend upward side by side from the platform 2. Immediately above the con-  
70 tacts 40 and 41 is located a dashpot mechanism comprising a shell member 44 which is adjustably secured to the member 3. The piston member 45 which slides in the shell member 44 carries at its lower end a disk  
75 46 of conducting material such as carbon. A member 48 is pivotally connected to a bracket 49 secured to the platform 2 between the dashpot 14 and the posts 42 and 43. One end of the member 48 is bifurcated, the bifurcation straddling the shell member of the dashpot 14. Pins 50 projecting from a  
80 sleeve 51 adjustably clamped to the shell member of the dashpot 14 engage the upper sides of the bifurcations to rock the member 48 on a downward movement of the armature 12. The opposite end of the member  
85 48 which considerably overbalances the bifurcated end engages an insulating button secured to the dashpot member 45 below the disk 46 and holds the disk 46 out of engagement with the contacts 40 and 41 when the  
90 armature 12 is in its lower position as shown in Figs. 2 and 3. When the armature 12 is held in its upper position, however, the disk 46 will slowly move into the position in which it engages the contacts 40 and 41, in which position it electrically connects these contacts. A support 54 which may be in the form of a tube of insulating material is secured to the upper side of the platform 2. A  
100 resistance conductor 55 is wound about this support. A sleeve 56 slides upon the tubular member 20. The upper end of the sleeve 56 is prevented from passing through the aperture in the platform 2 by an out turned  
105 flange portion 57. To release the tubular member 20 from the clutch member 24 the sleeve 56 may be manually forced upward to move the yoke of the clutch 24 upward until the pawl member of the clutch is forced out of the locking position by its engagement  
110 with the stop 26. This facilitates the trimming of the lamp.

A casing 60 which may be formed of sheet metal or the like incloses the lamp mechanism located between the cap 1 and the platform 2, the upper end of the casing being secured to the cap 1 in any suitable manner as by means of screws 61. The lower end of the casing closely embraces the platform 2.  
115 Apertures 62 are formed in the lower end of the casing above the platform 2 through which air may enter the casing to ventilate the lamp mechanism. The heated air passes out of the upper end of the casing, suitable spaces being left between the casing and the hood for that purpose. A hood or water guard 63 surrounds the lower end of the casing to protect the apertures 62. An annular hood or member 64 secured to the casing  
120 130

below the hood 63 supports a suitable transparent or translucent globe 66 in any suitable manner as by screws 67.

The globe 66 which surrounds the lamp mechanism located below the platform 2 is formed with a large opening at its lower end. A sheet metal annular member 68 is secured to the lower end of the globe in any suitable manner as by screws 69, which engage the globe above the out-turned end portion 70. A cylindrical member 71 having its lower end flared outward somewhat as shown, fits snugly in the central opening of the annular member with its axis in line with the axis of member 7. The member 71 may be secured to the annular member 68 by soldering or it may be detachably connected to the member 68. A wire netting 72 of comparatively fine mesh is secured to and extends across the upper end of the cylindrical member 71. A somewhat similar netting 73 extends transversely across the cylindrical member 71 about midway between its ends. This netting may be supported by annular members 74 and 75 as shown.

It will be observed that the lower netting 73 is about in a plane with the lower end of the annular member 68, while the upper netting 72 is considerably above this plane. As a result of this construction when the lamp is located out doors or elsewhere where it is subject to more or less violent gusts of wind the provisions of the cylindrical member 71 and the two screens or nettings separated by some distance as shown, prevents any sudden inrush of air into the interior of the globe. This is an important advantage as with lamps of this character it is desirable for their proper operation to admit sufficient amount of air in the casing to insure that the natural draft created by the heat of the arc will carry the arc products up through the tubular members 7, 3 and 4 to the apertures 5 through which they are discharged into the outside air. This draft tends materially to steady the arc which extends between the electrodes. A variation in the amount of the draft, particularly a sudden variation, produces a disturbing influence upon the operation of the lamp. By the use of the construction shown disturbances produced by gusts of the outside air are reduced to a minimum.

It may be desirable to admit a small amount of air at the junction between the annular member and the lower end of the globe and at the junction between the upper end of the globe and the hood. In many cases, however, it may be desirable to make these joints substantially air-tight, all of the air necessary to produce proper draft being then admitted through the cylindrical member 71.

In some cases I may dispense with the use of more than one screen, and I may also dispense in some cases with the use of the cylindrical member 71 or may modify its form, as

while the particular construction described works very well in practice I do not consider that this feature of my invention is limited to the particular arrangement of parts shown.

The circuit arrangements of the lamp are shown in Fig. 5 of the drawings. Referring to this figure, 80 and 81 represent the positive and negative terminals respectively, of the lamp. One terminal of the resistance conductor 55 is connected to the lamp terminal 80. The other terminal of the resistance conductor is connected to the contact 33 by a conductor 82. The contact 32 is connected to one terminal of the coils 13 which are in series with each other, by a conductor 83. The other terminal of the coils 13 is connected to the terminal 81 by a conductor 84.

A conductor 85 connects the terminal 80 with one terminal of the series coil 30, the other terminal of which is connected through a contact screw 86 with the positive electrode of the lamp as indicated by the conductor 87. In the actual construction of the lamp the electrode 9 is in electrical connection with the tubular member 7 through the bowed member 8 and pivotal supports, and the tubular member 7 is in direct contact with the screw 86. A conductor 87 connects the terminal 81 to the lower electrode 23.

A conductor 88 connects the contact 41 to the conductor 84. A conductor 89 connects the contact device 40 to the conductor 85 at the point 90. One terminal of the shunt coil 35 is connected to the conductor 82 by a conductor 91. The other terminal of the shunt coil 35 is connected to conductor 83 by a conductor 92. A conductor 94 connects the contact 37 to the conductor 85 at the point 95. A contact device 38 is connected to contact screws 8 by a conductor 96.

The out of service condition of the lamp which is the same as the running conditions of the lamp except that in the latter condition the contacts 32 and 33 are separated, is shown in Figs. 1 and 3 of the drawings. When the lamp is cut into service current will begin to flow between the terminals 80 and 81 through a circuit which includes a resistance, the conductor 55, conductor 82, contacts 32 and 33, conductor 83, winding of the coils 13 and conductor 84.

The passage of current through the coils 13 will cause the armature to be raised. This will normally move the electrode 23 into contact with the electrode 9 as hereinbefore described. When the electrodes 9 and 23 contact current will ordinarily begin to flow between the electrodes 9 and 23 through a circuit which includes the conductor 85, winding of the coil 30, contact screw 86, conductor 87, electrode 9, electrode 23 and conductor 87. Passage of current through the winding of the coil 30 causes the armature 31 to be rocked to separate the contacts 32 and 33.

When this occurs the winding of the coils 13 will no longer be operatively energized and the armature 12 and tubular member 20 will descend. The downward movement of the tubular member 20 and consequently of the electrode 23 will be limited by the engagement of the pawl of the clutch member 24 with the stop 27. This regulates the length of the arc struck after each feeding operation.

In case the extreme upward movement of the armature 12 is insufficient to move the electrode 23 into engagement with the electrode 9 no current will flow through the coil 30, and the contacts 32 and 33 will therefore be undisturbed. As the shell member of the dash-pot 14 no longer holds the member 48 in the position shown in Figs. 2 and 3 when the armature 12 is in its upper position, the dash-pot member 45 will slowly descend until the disk 46 connects the contacts 40 and 41. When this occurs a low resistance shunt including the conductor 88, contact 41, disk 46, contact 40, conductor 89 and a portion of the conductor 85 is thrown about the resistance conductor 55 and the winding of the coils 13 whereupon the winding of the coils 13 will instantly become deenergized, thus allowing the armature 12 to drop. With the dash-pot construction described the initial downward movement of the armature 12 is rapid. This will cause an initial rapid rocking movement of the member 48 and a quick break between the contact points 40 and 41 and disk 46. The armature 12 will no sooner reach this lower position than it will again be started upward by the energization of the coils 13 consequent upon breaking the low resistance shunt about them. As the upward movement of the armature 13 is considerably greater than the movement of the clutch member 24 between the stops 25 and 26 each energization of the coils 13 will cause the member 20 to be pulled through the clutch member 24 an amount equal to the difference in the movement of the armature and the clutch member 24. This will be automatically repeated until the electrodes 9 and 23 make contact and the coil 30 is energized.

The employment of the contact points 40 and 41 and cooperating mechanism serves a further purpose in that if, for any reason the electrical contact between the electrodes 23 and 9 is too poor to allow the passage of current between the electrodes when they first engage the feeding operation will be repeated and the repeated hammering of the electrode 23 against the electrode 9 will soon establish a working contact between the electrodes.

When the voltage of the arc is raised beyond its normal value as by the consumption of the negative electrode, the shunt coil 35 will be operatively energized and the contacts 37 and 38 will engage. This throws a low resistance shunt about the windings of the coils 30 which includes conductor 94,

contact 37, contact 38, and conductor 96. As soon as this occurs the contacts 32 and 33 will engage and a feeding operation of the lamp like that first described will take place.

The particular lamp heretofore shown and described is intended for operation in a constant current system. It will be obvious, however, to all those skilled in the art that my invention could readily be embodied in the lamp for operation in a constant potential system. It will be apparent to those skilled in the art that numerous changes may be made in the form of my invention without departing in any way from its spirit.

No claim is made in the present application to the arc inclosing globe and the arrangement of its air admitting passage. This construction forms the subject matter of my application Serial No. 225,296 filed September 21, 1904 as a division of this application.

What I claim as new and desire to secure by Letters Patent of the United States is,

1. In an arc lamp, a pair of cooperating electrodes, a feeding mechanism therefor for causing one or more relative approaching movements of said electrodes followed each by a relative separating movement, each approaching movement exceeding and each separating movement equaling the normal arc length, said feeding mechanism including means for causing the successive approaching and separating movements being continued until the electrodes engage.

2. In an arc lamp, a pair of electrodes, means for moving one of said electrodes a predetermined distance toward the other in the feeding operation of the lamp and then moving it away from the other a fixed distance which in the normal operation of the lamp is less than the first movement of the electrode, and means for causing such forward and backward movements of the electrode to be automatically repeated to bring about an engagement between the electrodes when the initial movement of the electrode is insufficient to bring about such engagement.

3. In an arc lamp, an electrode, a second electrode, a clutch for moving said second electrode toward the first-mentioned electrode, a second clutch for limiting the movement of the electrode in the opposite direction, the movement produced by the first-mentioned clutch being normally greater than the movement of the electrode in the opposite direction allowed by the second clutch, and means for causing the first-mentioned clutch to repeatedly advance the electrode when an initial advancement of the electrode is insufficient to bring about an engagement between the two electrodes.

4. In an arc lamp, a pair of electrodes, and means normally acting to move said electrodes into engagement with each other and thereafter causing them to separate a distance equal to the normal arc length, and

means for causing successive relative approaching and separating movement of said electrodes when the electrodes do not engage at the end of the first approaching movement, said means insuring that each approaching movement shall exceed and each separating movement equal the normal arc length.

5. In an arc lamp, a pair of relatively movable electrodes, means for moving one electrode toward the other comprising a winding in shunt to the arc between the electrodes and a cooperating movable armature, a switch controlling the energization of said winding including a member movable from one position in which it permits the energization of the winding to a second position in which it prevents the energization of said winding, and means controlled by the position of said armature for holding said member in said one position when said winding is deenergized but allowing said member to move into said second position when said winding is energized while said armature remains stationary.

6. In an arc lamp, a pair of relatively movable electrodes, and means for moving one electrode toward the other comprising a winding in shunt to the arc between the electrodes and cooperating movable armature, a switch controlling the energization of said winding including a member movable from one position in which it allows of the energization of the winding to a second position in which it prevents the energization of said winding, means controlled by the position of said armature for holding said member in said one position when said winding is deenergized but allowing said member to move into said second position when said winding is energized, and while said armature remains stationary and means for retarding the

movement of said member from said one position to said second position.

7. In an arc lamp, a stationary electrode, a movable electrode, feeding mechanism for causing said movable electrode to be moved first toward the stationary electrode a distance exceeding and then away from the stationary electrode a distance equaling the normal arc length, said mechanism including means for causing said movement to be repeated until the electrodes engage, if such engagement does not occur on the initial movement.

8. In an arc lamp, a pair of electrodes arranged to be brought together and then separated to strike an arc, and means for retarding the separating movement of the electrodes, said means becoming effective only after a partial separating movement has occurred.

9. In an arc lamp, a pair of electrodes and mechanism constructed and arranged to bring the electrodes together and then cause them to separate to strike an arc, and means for retarding the final separating but not the initial movement of the electrodes.

10. In an arc lamp, an electrode, a second electrode and means for moving it into engagement with the first electrode and then causing it to move away from the first electrode to strike an arc, and means for permitting the initial portion of the movement of said second electrode away from the other electrode to be rapid and for causing the remainder of the latter movement to be slow.

In witness whereof I have hereunto set my hand this 19th day of May, 1904.

WILLIAM S. WEEDON.

Witnesses:

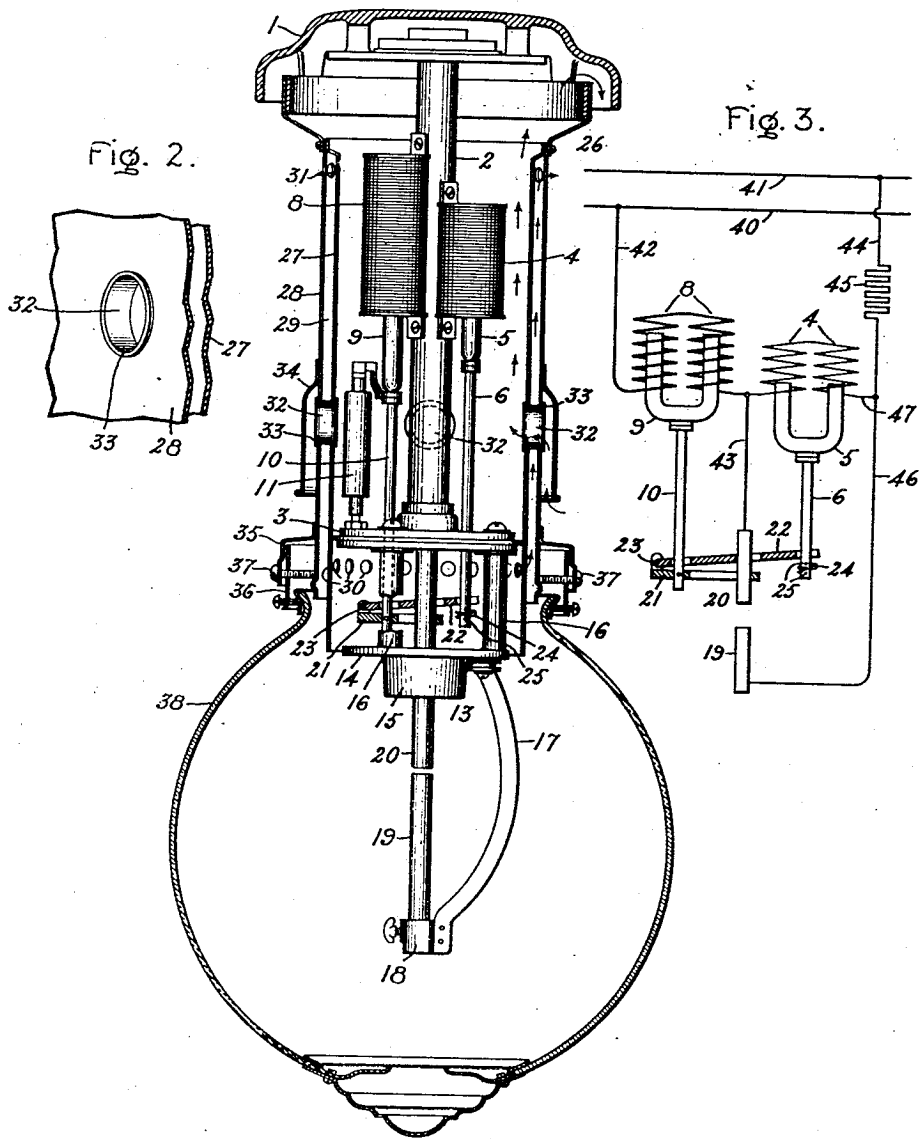
BENJAMIN B. HULL,  
HELEN ORFORD.

R. FLEMING.

ARC LAMP.

APPLICATION FILED MAY 18, 1904.

Fig. 1.



Witnesses:

*George M. Tilden.*  
*Helen Orford*

Inventor:

Richard Fleming,  
by *Albert G. Davis*  
Att'y.



## UNITED STATES PATENT OFFICE.

RICHARD FLEMING, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 890,763.

Specification of Letters Patent.

Patented June 16, 1908.

Application filed May 18, 1904. Serial No. 208,495.

*To all whom it may concern:*

Be it known that I, RICHARD FLEMING, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention relates to arc lamps, more particularly of the type in which the electrodes employed are such as to insure a flaming or luminous arc.

The invention consists in certain features of construction and operation of the feeding mechanism of the lamp and in the means employed for disposing of the fumes from the arc and for ventilating the lamp mechanism.

The features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be had to the accompanying drawings and description in which I have illustrated and described one embodiment of my invention.

Of the drawings, Figure 1 is a sectional elevation of an arc lamp embodying my invention; Fig. 2 is a perspective view showing a portion of the combined lamp casing and chimney; and Fig. 3 is a diagram illustrating the circuit arrangement of the lamp.

Referring to the drawings, 1 represents a hood or top of the usual form. A hollow post 2 extends downward from the center of the hood 1 to which it is rigidly secured in any suitable manner. The lower end of the post 2 supports a disk shaped horizontal platform 3. A pair of vertical solenoid shunt coils 4 are secured to the post 2 between its ends. A rod 6 carried by the movable armature 5 cooperating with the shunt coils 4 passes through an aperture formed for the purpose in the platform 3. A pair of vertical solenoid coils 8, somewhat longer than the coils 4, are also secured to the post 2 between its ends at the side of the post 2 opposite to that upon which the shunt coils 4 are secured. A rod 10 extending through the platform 3 has its upper end secured to the movable armature 9 cooperating with the coils. One member of a dash-pot 11 is secured to the armature 9, the other member of the dash-pot being secured to the platform 3. The dash-pot 11 is arranged to prevent

a rapid upward movement of the armature 9 when the coils 8 are energized.

An annular member 13 having a radially extending portion 14 and a cylindrical portion 15 is carried below the platform 3 by posts 16. The radial portion 14 is parallel to the platform 3. A bent arm 17 secured to the under side of the radial portion 14 has a socket 18 formed in its lower end in which the lower electrode 19 of the lamp is held in line with the axis of the hollow post 2. The lower electrode of the lamp is preferably the negative electrode when the lamp is to be operated with direct current and contains or is formed of some material which yields a flaming or luminous arc, such for instance as the magnetic oxid of iron or the like.

The upper electrode 20 of the lamp, which may be formed of the same or different material from that of which the electrode 19 is composed, slides within the hollow post 2 and has its lower end projecting through the cylindrical portion 15.

The lower end of the rod 10 has secured to it an arm 21 which extends at right angles to the rod. This arm 21 has formed in it an elongated slot or passage through which the electrode 20 passes. A member 22 is pivoted to the arm 21 at the point 23. The member 22 is also formed with an elongated slot in it through which the electrode 20 passes. The openings in the arm 21 and member 22 are so proportioned and arranged that in the normal operation of the lamp the electrode 20 is rigidly held between the right hand end wall of the slot in the member 21 and the left hand end wall of the slot in the member 22. The extreme right hand end of the member 22 is bifurcated to slidingly receive the lower end of the rod 6. A projection 24 which may be in the form of a pin inserted in one of a series of holes 25 in the lower end of the rod 6 serves as a means for raising the right hand end of the member 22 to release the upper electrode at a suitable stage in the operation of the lamp.

A casing 26 having its upper end secured in any suitable manner to the hood 1 surrounds the lamp mechanism. The casing comprises an inner cylindrical member 27 which closely embraces the platform 3 and which extends from a point adjacent the radial portion of the member 14 to a point near the upper end of the casing, and an outer cy-

lindrical member 28 which may be concentric with the member 27 and which is separated therefrom by an annular space or chamber 29 which extends from a point near the upper end of the casing to a point about midway between the platform 3 and the radial portion 14 of the member 13. Apertures 30 are formed in the portion of the member 27 immediately below the platform 3. Apertures 31 are formed in the member 28 near its upper end.

Passages 32 extend through the casing 26. These passages may be formed by sections of pipe 33 which extend through apertures formed in line with each other in the members 27 and 28; the ends of the pipe sections 33 may be upset or turned outwardly as shown to lock the pipe sections in place and to make tight joints between the pipe sections and the members 27 and 28. A hood or water guard 34 is carried by the member 28 in such manner as to prevent the passage of moisture or dust into the interior of the member 27.

An annular hood 35 secured to the member 28 near its lower end supports an annular member 36 in any suitable manner as by means of screws 37. The member 36 supports in turn a transparent or translucent globe 38 which surrounds the lower portion of the lamp mechanism and protects or incloses the arc.

Referring to Fig. 3 of the drawings, 40 and 41 represent conductors which supply current to the lamp terminals. A conductor 42 leads from the conductor 40 to one terminal of the series coils 8. The other terminal of the series coils 8 is connected to the upper electrode 20 of the lamp by a conductor 43. A conductor 44 connects the line 41 to one terminal of the resistance coil 45 (not shown in the other figures of the drawings). The other terminal of the resistance coil 45 is connected to the lower electrode of the lamp by a conductor 46. A conductor 47 connects the conductor 46 with one terminal of the shunt coils 4. The other terminal of the shunt coils 4 is connected to the conductor 43.

Assuming the position of the electrodes of the lamp to be that shown in Fig. 1, in which it is seen they are separated by a short distance, upon connecting the lamp in circuit the shunt coils 4 will be energized and the armature 5 will raise the rod 6. The engagement of the member 22 by the projection 24 and consequent upward movement of the member 22 will release the electrode 20 which will thereupon drop into contact with the electrode 19. Upon contact between the electrodes current will begin to flow between them. This will energize the series coils and will at the same time so decrease the voltage on the shunt coils that they will be practically deenergized and the armature 5 will drop. When the series coils 8 are energized

the armature 9 and rod 10 will be raised. As the deenergization of the shunt coils occurs simultaneously with the energization of the series coils, and as a rapid movement of the armature 9 is prevented by the dash-pot 11, the electrode 20 will be immediately clamped between the members 21 and 22 and will be raised by the upward movement of the armature 9 to draw an arc of the proper length between the electrodes 19 and 20.

When by reason of the consumption of the electrodes, or from other causes, the voltage of the arc increases sufficiently beyond its original value the shunt coils 5 will cause a feeding from time to time of the upper electrode by means of the engagement between the projection 24 and the member 22. When the lamp is thrown out of circuit the coils 4 and 8 will, of course, become entirely deenergized and the armatures will both descend to their original position. Inasmuch, however, as the electrodes when running long enough to become hot will necessarily be consumed somewhat, the downward movement of the armature 9 will not be great enough to allow the lower end of the electrodes 20 to engage the end of the electrode 19, and the electrodes will therefore be separated as shown in Fig. 1. This is an important feature, as when the electrodes are allowed to come together while hot they are apt to stick or weld together.

The gases or vapors produced by the arc mixed with suitable amounts of air which may enter the interior of the globe between its upper end and the member 36 will pass through the apertures 30 into the space 29 and then out of the chamber through the apertures 31, as indicated by the small arrows in Fig. 1. The distance between the apertures 30 and 31 and the dimensions of the space or chamber 29 are such as to insure a natural draft ample for the purpose. The platform 3 forms a partition which prevents any of the arc products from entering the chamber above the platform in which the lamp mechanism is located.

More or less solid material is condensed upon the inner walls of the chamber 29 from the vapor passing into the chamber through the aperture 30. This may be removed from time to time by jarring the casing or in any other suitable manner. To facilitate the removal of the condensed material the casing may be removed from the lamp if desired, though this is not usually necessary. The air for cooling the coils and other mechanism located within the casing member 27 passes in through the passages 32, and out between the upper end of the casing and the hood 1, as indicated by the small arrows in the drawings.

Changes may be made in the form and proportion of the parts comprising the construction illustrated without departing from the

spirit of my invention, and I do not intend the claims hereinafter made to be limited to the construction shown more than is made necessary by the state of the art.

5 What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an arc lamp, a movable electrode and mechanism for moving it, a casing surrounding said mechanism, a second casing surrounding the first but separated therefrom by a space through which the arc products can pass, and a member connecting said casings, said member being formed with a passage through it by means of which the ventilation of the mechanism is secured.

15 2 In an arc lamp, a movable electrode and mechanism for moving it, a casing inclosing said mechanism, a second casing surrounding the first but separated therefrom to form a space through which the arc products can pass from the lamp, both of said casings having apertures formed in them, and a pipe or conduit connecting said apertures.

3: In an arc lamp, the combination with a horizontal partition, of a double-walled vertical annular casing through which the vapors are drawn by natural draft and in which they condense before their escape from the lamp, suitable openings being provided for the ventilation of the interior of the lamp and the cooling of the inner wall of the annular casing.

4. In combination in an arc lamp with a horizontal partition above the arc, a double-walled annular casing through which the vapors generated are forced to pass before escaping from the lamp, perforations in the lower and upper parts of said casing for said vapors, and tubular lateral passages through the wall of the casing to admit fresh air.

In witness whereof, I have hereunto set my hand this 16th day of May, 1904.

RICHARD FLEMING.

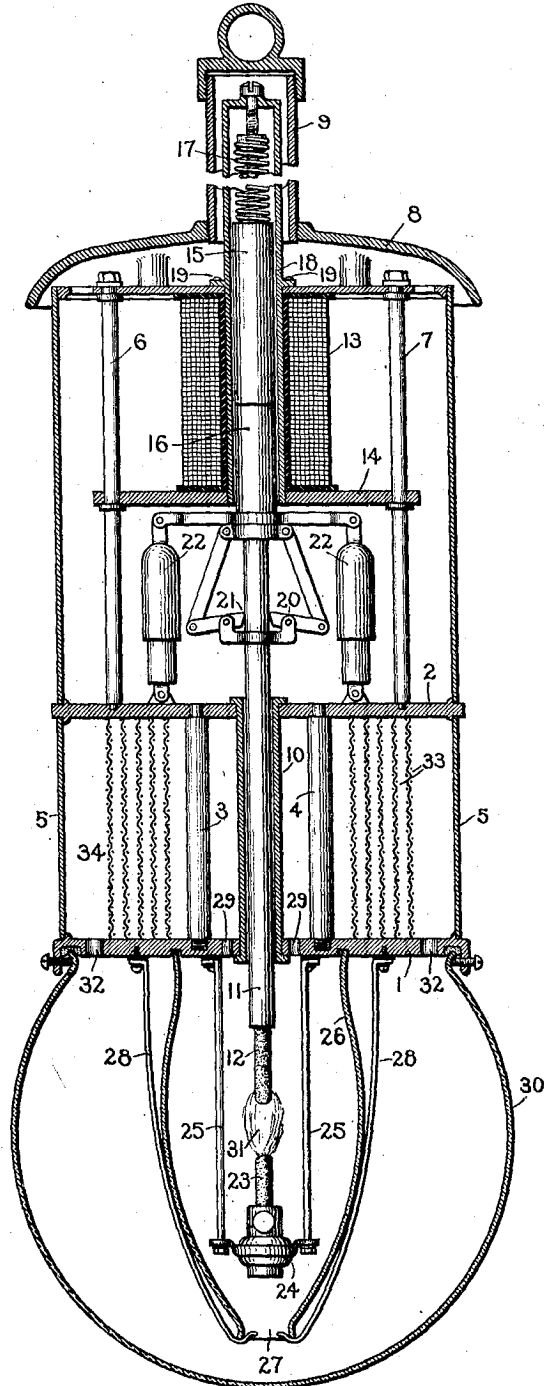
Witnesses:

DUGALD MCK. MCKILLOP,  
JOHN A. McMANUS.

No. 892,768.

PATENTED JULY 7, 1908.

C. P. STEINMETZ.  
ELECTRIC ARC LAMP.  
APPLICATION FILED MAY 31, 1902.



Witnesses.  
*J. Ellis Glenn.*  
*Helen Orford*

INVENTOR.  
Charles P. Steinmetz  
by *Albert S. Davis*  
ATTY.

# UNITED STATES PATENT OFFICE.

CHARLES P. STEINMETZ, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ELECTRIC-ARC LAMP.

No. 892,768.

Specification of Letters Patent.

Patented July 7, 1908.

Application filed May 31, 1902. Serial No. 109,600.

*To all whom it may concern:*

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

My present invention comprises means for directing the deposition of solid matter emitted by luminous or flaming electric arcs. If some such means as is hereinafter described is not employed the solid matter which is emitted by arcs of the character mentioned, and which appears in the form of smoke, is deposited upon the inclosing globe, thereby forming a coating which obscures the light to a greater or less extent. In accordance with my invention the solid matter is directed away from the arc-inclosing globe and is then removed or eliminated from the air currents which carry it. Discoloration of the inclosing globe or globes is thus prevented and one of the difficulties attendant upon the use of flaming arcs is thus removed.

The novel features which I believe are characteristic of my invention I have pointed out with particularity in the appended claims, while in the following specification which is to be taken in connection with the accompanying drawings will be found a detailed description of one embodiment of the many which my invention may assume.

The arc lamp represented in the drawings is intended for use on constant potential circuits and in the instance shown is of the shunt feed variety, that is to say, the electrodes of the lamp are normally urged apart by a spring or other mechanical device and are moved toward each other through the operation of a magnet shunted about the electrodes.

In the drawings, 1 and 2 represent plates forming a portion of the framework of a lamp. These plates are separated from each other and held in place by means of spacing rods of which two are indicated at 3 and 4 respectively. The space between these plates is such that when inclosed by the cylindrical casing indicated in section at 5, a chamber of moderate dimensions is formed. The upper plate 2 is suspended by means of rods such as 6 and 7 from the top plate 8 of the lamp. The parts thus described constitute the main framework of the lamp

from which the working parts are supported. The lamp as a whole is suspended by a tubular extension 9 screwed into the top plate of the lamp and provided at its projecting end with a ring or other attaching device. In the drawings this tubular extension is shown as partly broken away owing to lack of space to represent the full length of the extension in the drawings.

Located centrally with respect to the plates 1 and 2 is a tube 10 constituting a guide for the rod 11 which carries the upper electrode 12 of the lamp. This rod 11 is actuated by means of the solenoid 13 supported centrally in the lamp between the top plate 8 and a cross piece 14 carried by the vertical supporting rods 6 and 7. Within the opening in this solenoid is a tubular armature or core 15 of magnetic material in which slides the rod 11 carrying the upper electrode. To the lower portion of the core 15 is fastened a tubular member 16 of non-magnetic material carrying a clutch 20 arranged to engage the electrode rod 11 as indicated at 21.

The armature 15 with all the parts attached thereto is suspended from a helical spring 17; the upper end of which is fastened at the top of a tube 18 having a flange resting upon the top plate 8 of the lamp as indicated and secured in position by screws 19 or any other suitable means. A dash-pot or dash-pots 22 may be used to prevent too violent motion of the electrode-carrying rod 11 under the influence of current in the solenoid 13. The lower electrode 23 is supported in a holder 24 carried by rods 25 depending from the lower plate 1 of the lamp frame.

The arc which is formed between the electrodes is surrounded by a small inclosing globe 26 open at its lower end as indicated at 27 and maintained with its upper edge in close contact with the plate 1 by hooked wires 28 attached to the plate 1. The interior of this arc-inclosing globe communicates with the interior of the chamber 34 formed between the plates 1 and 2 and the cylindrical casing 5, this communication being afforded by means of a suitable number of openings in the lower plate 1, two of these openings being indicated at 29 in the cross sectional view of the plate 1. The arc-inclosing globe 26 is in turn surrounded by a spherical or other suitably shaped outer globe 30, the upper edge of which forms a fairly air-tight joint with

the plate 1 from which it is supported as indicated.

When the lamp is in operation the arc indicated at 31 heats the air immediately surrounding it and this air rises through the set of openings 29 into the chamber 34, thereby producing a draft up through the opening 27 at the lower end of the inner arc-inclosing globe. This draft causes air to be drawn from the chamber 34 through suitable openings, some of which are indicated at 32, down into the outer globe 30. The action described causes a continuous circulation of air from the inner arc-inclosing globe up into the chamber 34, then down from the chamber into the inclosing globe 30 and from thence into the inner inclosing globe and so on. This directed circulation of heated air from the arc permits the removal of solid matter emitted from the arc almost as soon as it is produced and for this purpose I make use of a series of screens 33 formed of wire gauze of moderately small mesh, these screens being located concentrically in the chamber 34. In the drawings these screens are indicated in cross section and as shown it will readily be seen that the air which is caused to circulate by reason of the heating action of the arc is forced to pass through these screens before returning to the chamber formed between the inner and outer globes 26 and 30. The solid matter given off by the arc in the form of smoke or vapor is thus deposited in the meshes of the screens, thereby preventing its deposition upon the arc-inclosing globe, the effect of which would of course be to seriously reduce the amount of light transmitted.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. The combination in an electric arc lamp, of means for creating within the lamp a circular air current carrying smoke and other products of combustion from the arc, and means for depositing said products at a predetermined point in the air circuit.

2. The combination in an electric arc lamp, of means for creating within the lamp a circular air current carrying smoke and other products of combustion from the arc, and a depositing chamber constituting a part of the air circuit.

3. The combination in an electric arc lamp, of means for creating within the lamp a circular air current carrying smoke and other products of combustion from the arc, and a filtering and depositing chamber within the air circuit.

4. The combination in an electric arc lamp, of means for creating within the lamp a circular air current carrying smoke and other products of combustion from the arc; a depositing chamber constituting a part of the air circuit, and filtering and depositing screens within said chamber.

5. The combination in an electric arc lamp, of means for creating in the lamp a circular air current carrying smoke and other products of combustion from the arc, and filtering and depositing screens located at a point in the air circuit.

6. The combination in an electric arc lamp, of an inclosing globe, means for creating through the globe a circular air current carrying smoke and other products of combustion from the arc and globe, and means for depositing such products outside the globe within the air circuit.

7. The combination in an electric arc lamp, of an elongated arc inclosing globe, a chamber distinct from the globe communicating with the latter at its two ends for the deposition of smoke and other products of combustion, and means for causing a circular air current through the globe and chamber.

8. The combination in an electric arc lamp of an elongated arc inclosing globe, a chamber distinct from the globe communicating with the latter at its two ends for the deposition of smoke and other products of combustion, means for causing a circular air current through the globe and chamber, and means contained in the chamber for promoting the deposition of arc products the same.

9. The combination in an electric arc lamp of a pair of electrodes in axial alignment, an elongated arc inclosing globe, and a chamber for depositing arc products of combustion in communication with the two ends of the elongated arc inclosing globe.

10. In an arc lamp, the combination of means for creating a recurrent circulation of a confined body of air and arc products of combustion along and over the arc, with a chamber remote from the arc through which the said circulation passes, for depositing products of combustion.

In witness whereof I have hereunto set my hand this 28th day of May, 1902.

CHARLES P. STEINMETZ.

Witnesses:

BENJAMIN B. HULL,  
HELEN ORFORD.

No. 895,594.

PATENTED AUG. 11, 1908.

B. A. STOWE.  
ARC LAMP.

APPLICATION FILED AUG. 3, 1905.

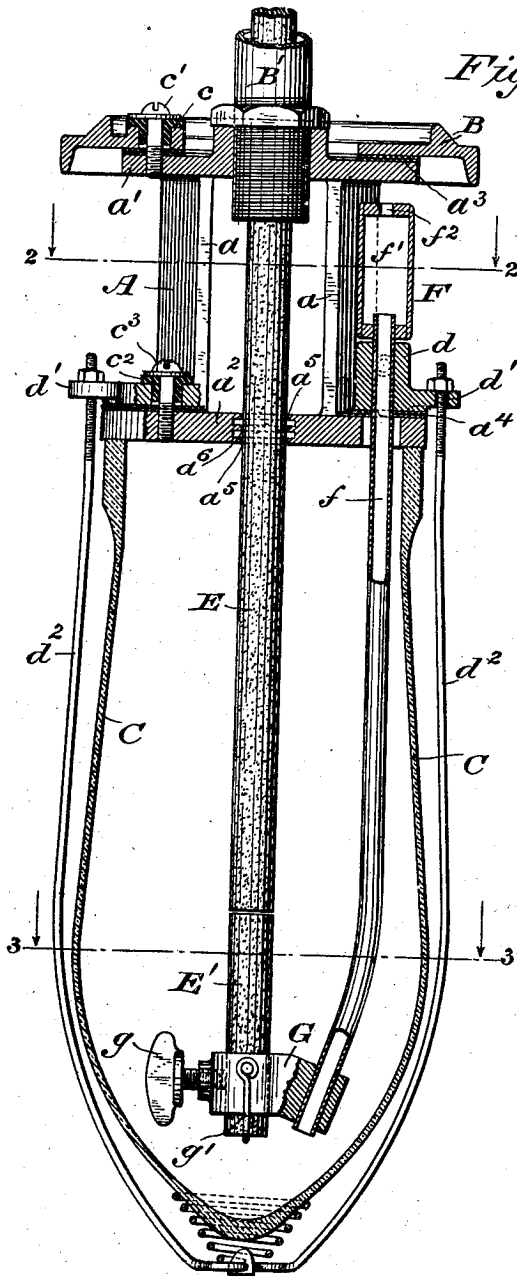


Fig. 1.

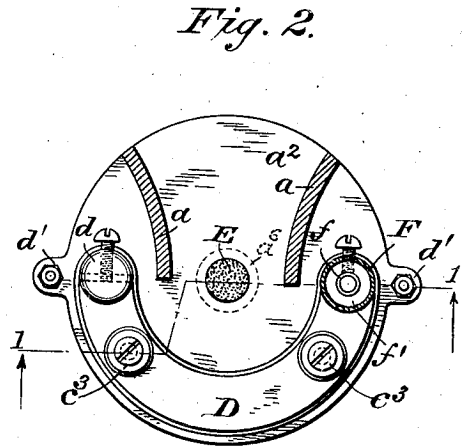


Fig. 2.

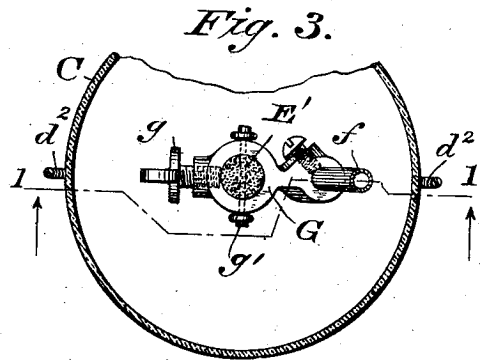


Fig. 3.

WITNESSES:  
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INVENTOR:  
Bernard A. Stowe  
by his attorney  
J. O. Kay

# UNITED STATES PATENT OFFICE.

BERNARD A. STOWE, OF CLEVELAND, OHIO, ASSIGNOR TO THE JANDUS ELECTRIC COMPANY,  
OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

## ARC-LAMP.

No. 895,594.

Specification of Letters Patent.

Patented Aug. 11, 1908.

Application filed August 3, 1905. Serial No. 272,488.

To all whom it may concern:

Be it known that I, BERNARD A. STOWE, a citizen of the United States, resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in 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.

My invention relates to arc-lamps of the inclosed type and particularly to the means embodied therein which are adapted to control the rate of consumption of the carbons consequent upon the fluctuations of the arc and the pumping action of the moving carbons.

It is the object of the invention to provide means which shall prolong the life of the carbons and which shall regulate and control the interchange of gases between the arc-chamber and the atmosphere, so as to maintain a practically uniform mixture of gases in the arc-chamber and thus effect a steady and uniform burning at the arc.

Said invention is designed to be a modification, and an improvement in simple form, of the arc-lamp shown and described in U. S. Letters Patent, No. 797,629, dated August 22, 1905, and consists of the means hereinafter fully described and specifically set forth in the claims.

The annexed drawing and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawing: Figure 1 represents a vertical section of an inclosed arc-lamp embodying my invention, taken upon the planes designated by the lines 1-1, Figs. 2 and 3, portions of the lamp cut by the planes of section being shown in elevation; and Figs. 2 and 3 represent horizontal sections, taken upon the planes designated by the lines 2-2, and 3-3, respectively, Fig. 1.

My invention is embodied in a structure A serving as a supporting member together with several other elements hereinafter described. Said structure comprises upright body-portions  $a$  formed with a laterally-projecting upper member  $a'$  and a laterally-projecting lower member  $a^2$ . The upper mem-

ber  $a'$  is secured to the floor-plate B and forms the connecting mechanical supporting medium between the center tube B' and the lower portion of the lamp. Said supporting member A is insulated from the floor-plate B by means of mica-sheets  $a^3$  and insulated bushings  $c$  surrounding the fastening screws  $c'$ , as will be readily understood.

Suitably secured to the upper surface of the member  $a^2$  is a curved plate D provided with two upwardly-extending projections  $d$  and two laterally-extending ears  $d'$ , said plate D being insulated from the member  $a^2$  by means of mica-sheets  $a^4$  and insulated bushings  $c^2$  surrounding the fastening screws  $c^2$ . To the ears  $d'$  are secured the rods  $d^2$  for supporting the glass globe C against the lower surface of the member  $a^2$ . To one projection  $d$  is connected a terminal of the electrical conductor, while passing through the other projection and suitably and adjustably supported therein by means of a small screw, Fig. 2 is an elongated attenuated tube  $f$  to be hereinafter more fully described. The lower member  $a^2$  of the member A is provided with a central opening  $a^5$  which provides a channel for receiving the positive carbon E, said channel being of a diameter substantially equal to that of said carbon so as to permit of the movement or pumping action of the latter through the same but which prevents the ready escape of the arc-gases through the same. Two shallow annular transverse chambers  $a^6$  intersecting the member  $a^2$  intermediate of the lower and upper surfaces of the latter, and communicating with the channel  $a^5$  serve as a gas-check or reservoir for such of the arc-gases as do escape from the arc-chamber through the opening  $a^5$  during the pumping of the carbons, and thus prevent the entrance of oxygen to the arc-chamber when the carbons again recede from each other and the gas is again drawn into the chamber.

I have provided a reservoir F into and from which the arc-gases or, more properly, the heaviest portion of the arc-gases, may freely enter and withdraw during the relative movements of the carbons or during the changes of temperature in the arc-chamber, such gas-reservoir or outlet being wholly independent of the outlet  $a^5$  surrounding the positive carbon E.

I have found that the temperature of the gases in the inclosure is a function of the ten-

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sion of the arc, and that the entrance or exit of the positive carbon does not correspondingly expel or draw in external air. On the other hand, the drop in temperature becomes so marked when the arc shortens and the voltage decreases, that the contraction of the gases exceeds in amount the increased volume of positive carbon resulting from the corresponding entrance of such carbon. The contrary is also true when the arc lengthens and the voltage increases. This does not, however, affect the principle of operation of the lamp. Said reservoir F comprises an elongated attenuated tube *f* suitably secured at its upper end in one of the projections *d* and supporting at its lower end the negative carbon *E'* which is secured thereto by means of a member *G* having a central recess for receiving the carbon, a pivoted support *g'* upon which the latter rests, and a clamp *g* for securing the carbon in such recess. It will be noted that the lower end of said tube *f* thus taps the lower portion of the arc-chamber and permits of the entrance and escape of the heaviest arc-gases during the relative movements of the carbons. Removably and adjustably supported upon the upper end of the tube *f* and communicating therewith is a second member of the reservoir F, such member comprising a chamber *f'* of enlarged cross-section provided with an outlet *f''* of restricted cross-section communicating directly with the atmosphere. This chamber *f'* I shall refer to as the "expansion and diffusion chamber". The volume of the reservoir F is such that it will be greater than the difference between the volume of the gaseous contents of the arc-chamber at a given temperature and pressure and the volume of such gaseous contents at the same pressure and the maximum temperature imparted to it during the lamp's operation.

I am aware that an outlet for the arc-gases from the arc-chamber which is independent of the upper end or outlet of the channel which forms the feed-opening for the movable electrode and which is a freer path of escape for such gases than said channel-outlet, is not new, the same being shown and described in U. S. Letters Patent No. 797,629, to which I referred above, said independent outlet comprising in said prior application, as it does in this, an elongated attenuated tube communicating directly with the arc-chamber and a chamber of enlarged cross-sectional area communicating with said tube and with the atmosphere. The function of said independent outlet is, briefly, to serve as a reservoir for the gases that are exhaled from the arc-chamber during the breathing of the lamp, such gases again being inhaled into the arc-chamber when the temperature within the arc-chamber falls or the carbons move farther apart, the volume of said reservoir

being, as noted above, in excess of the difference between the maximum and minimum volumes of the arc-chamber, so that the oxygen of the atmosphere cannot enter the arc-chamber except by diffusion through the interposed volume of gases in the reservoir, the exclusion of the oxygen thus procuring a more economical consumption of the carbons, as will be understood. The attenuated form of the tube *f* keeps a sufficient volume of arc-gases between the arc-chamber and the atmosphere, and the chamber *f'* acts as a diffusion chamber and also as a gas-check which prevents, by its enlarged cross-sectional area, the sudden expulsion of the arc-gases into the atmosphere due to their sudden expansion from various causes in the tube *f*. In this form of lamp, the gases intermediate of the lower end of the tube *f* and the arc also act as a reservoir of gas which exercises a function similar to that of the reservoir formed by tube *f*, since any diffusion of oxygen from the exterior must take place through it before it reaches the combustion area. However, I have discovered that said independent outlet best subserves the general purposes above outlined, if it acts as a reservoir for the heaviest arc-gases which are more immobile than the light gases, prevents more effectually the diffusion of the oxygen, and acts better as a cushion against sudden expansion. I have, therefore, provided an inclosure forming an arc-chamber in combination with an independent outlet which taps the lower portion of the arc-chamber and serves as a reservoir for the heavy gases which will be found in that part of the chamber. I am not aware that this independent outlet has been thus utilized, but only as a reservoir which taps the upper portion of the arc-chamber and thus receives the lightest gases, which is not as serviceable and economical as my improved construction for the reasons given above. One advantage which this improved form of lamp presents over that forming the subject-matter of my above-named application, arises out of the fact that any cooler gases containing oxygen entering from the exterior gain access to the interior of the inclosure at the bottom and hence, being heavier, tend to remain there and do not readily reach the combustion area, whereas in my previously constructed lamp all communication with the exterior was had at the upper portion of the inclosure. In the latter case the heavier exterior air when it gained access passed downwardly and thus through or in immediate proximity to the combustion area.

Having thus described my invention in detail, that which I particularly point out and distinctly claim is:

1. In an arc-lamp, the combination with an inclosure forming an arc-chamber; of a member connected therewith communicat-

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ing with the atmosphere and tapping that portion of the arc-chamber that contains the heaviest gases, the end of said member communicating with the atmosphere being  
5 provided with a diffusion chamber.

2. In an arc-lamp, the combination with an inclosure forming an arc-chamber; of a member connected therewith embodying an attenuated tube and a chamber of enlarged  
10 cross-sectional area, said member communicating with the atmosphere and tapping that portion of the arc-chamber that contains the heaviest gases.

3. In an arc-lamp, the combination with an inclosure forming an arc-chamber; of a member connected therewith embodying an attenuated tube tapping that portion of the arc-chamber that contains the heaviest  
15 gases, and a chamber of enlarged cross-sectional area communicating with the atmosphere.  
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4. In an arc-lamp, the combination with an inclosure forming an arc-chamber; of a member connected therewith embodying an

elongated attenuated tube tapping that  
25 portion of the arc-chamber that contains the heaviest gases, and a chamber of enlarged cross-sectional area provided with an outlet of constricted cross-sectional area communicating with the atmosphere.

5. An arc-lamp having an inclosed arc-chamber, an elongated attenuated tube tapping that portion of the arc-chamber that contains the heaviest gases, and a member  
30 of enlarged cross-sectional area communicating with said tube and with the atmosphere.  
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6. An arc-lamp having an inclosed arc-chamber, an attenuated tube communicating with the interior of the latter, and a member of enlarged cross-sectional area remov-  
40 ably secured to and communicating with said tube and open to the atmosphere.

Signed by me this 26th day of July 1905.

BERNARD A. STOWE.

Attested by:

D. T. DAVIES,  
A. E. MERKEL.

R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED MAY 1, 1905.

Patented Oct. 13, 1908.  
2 SHEETS—SHEET 1.

900,718.

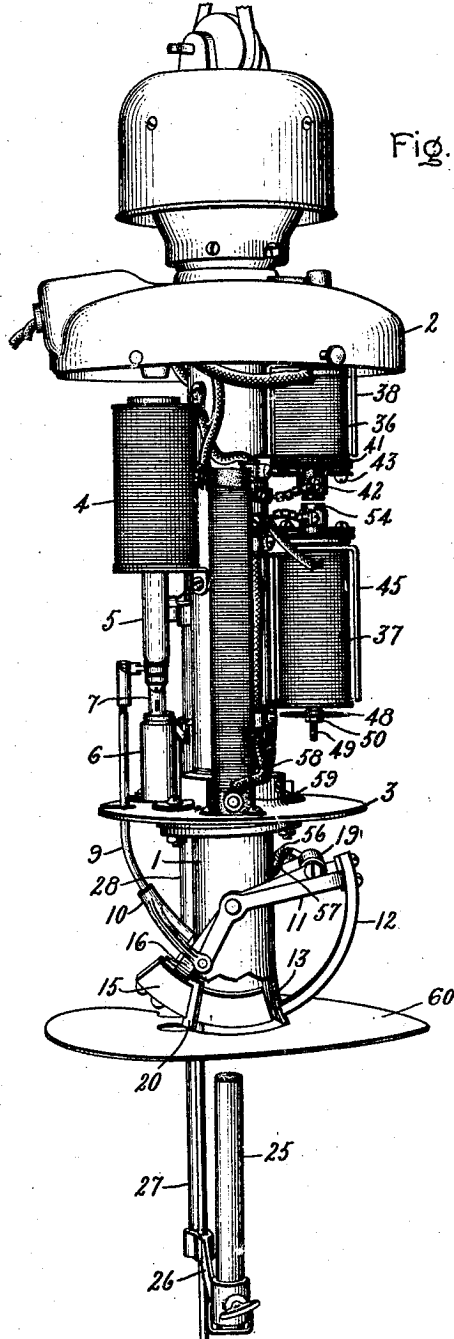


Fig. 1.

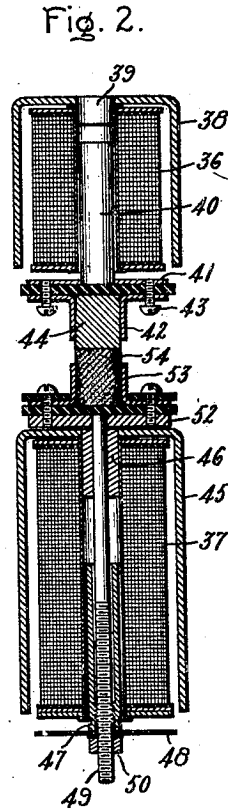


Fig. 2.

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*John E. Hubbard*  
*Helen Clifford*

Inventors:

Richard Fleming,  
Cromwell A.B. Halvorson Jr  
by *Albert Davis*  
Att'y

R. FLEMING & C. A. B. HALVORSON, Jr.  
ARC LAMP.

APPLICATION FILED MAY 1, 1905.

900,718.

Patented Oct. 13, 1908.

2 SHEETS—SHEET 2.

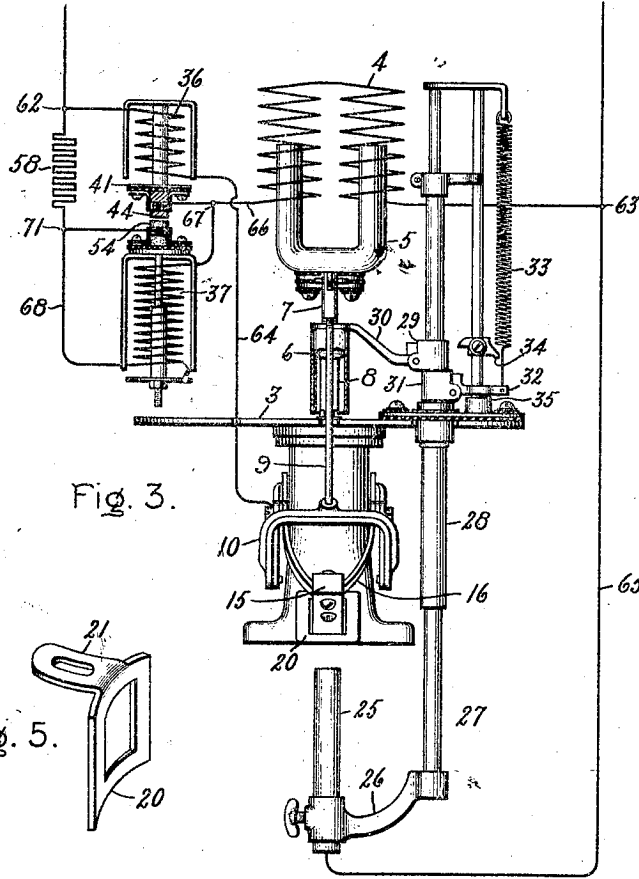


Fig. 3.

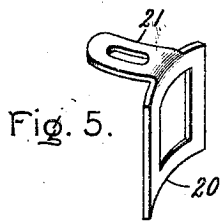


Fig. 5.

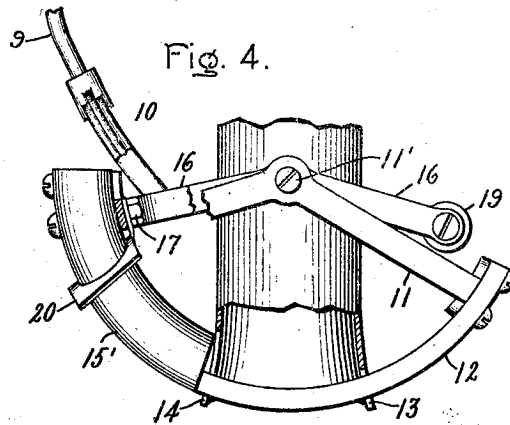


Fig. 4.

Witnesses:

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Inventors:

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Cromwell A. B. Halvorson Jr.  
by *Albert S. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 900,718.

Specification of Letters Patent.

Patented Oct. 13, 1908.

Application filed May 1, 1905. Serial No. 258,214.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, JR., citizens of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

Our present invention relates to arc lamps, and more particularly to arc lamps of the type in which the electrodes employed are such that flaming or luminous arcs are obtained which furnish the major portion of the light given by the lamps.

Our present invention is shown as embodied in a lamp structure which is a modification of that shown in our application Serial No. 181,332, filed November 16, 1903.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of our invention, however, reference may be had to the accompanying drawings and descriptive matter in which we have illustrated and described forms in which our invention may be embodied.

Of the drawings, Figure 1 is a perspective view of an arc lamp with the casing and globe removed; Fig. 2 is an elevation with parts in section and broken away showing the circuit controlling means of the lamp; Fig. 3 is a diagrammatic representation of the lamp and its circuit arrangements; Fig. 4 is a partial elevation with parts broken away and in section showing a modified form of electrode construction; and Fig. 5 is a perspective view of a detail.

In the drawings, 1 represents a central draft tube or chimney forming the back-bone of the lamp proper. Ordinarily the chimney or draft tube is formed in three sections, one above the hood 2 of the lamp, one between the hood 2 and the platform or partition 3, and a third section below the platform 3. The electrode-feeding mechanism of the lamp proper is located between the hood 2 and platform 3.

A pair of similar solenoid coils 4 are arranged side by side and secured to the middle section of the chimney member 1. The legs of a U-shaped armature 5 project into the coils 4. The movable member 6 of a dash-pot is secured to the under side of the yoke

of the armature 5 by a connecting portion or stem 7. The stationary member 8 of the dash-pot is secured to the platform 3. A connecting rod 9 has its upper end secured to but insulated from the armature 5. The lower end of the connecting rod 9, which is preferably curved as shown in Figs. 1 and 4, is secured to the yoke of U-shaped member 10. The ends of the legs of the U-shaped member 10 are pivotally connected to the ends of a U-shaped member 11 which is pivotally connected at diametrically-opposed points to the lower end or section of the chimney member 1 by means of pintles or trunnions 11' carried by the chimney member. The yoke portion of the member 11 is secured to one end of an arc-shaped bar advantageously made out of some metal such as wrought copper. This bar forms the starting portion of the positive electrode.

When the member 11 is oscillated about its pivotal point of support by the reciprocation of the armature 5, the member 12, which in the position shown in Fig. 1 of the drawings has its lower end substantially flush with the right-hand wall of the chimney 1, passes through the lower end of the chimney through slots 13 and 14 (see Fig. 4) formed in the right end and left-hand side of the member 1. In the construction shown the bar 12 is curved about its pivotal point of support as a center and passes through the center of the chimney member when oscillated.

In the lamp shown in Fig. 1, the main or working portion of the positive electrode of the lamp is in the form of a curved bar 15 of metal, such as wrought copper, rectangular and considerably larger in cross-section than the starting portion 12. The bar 15 is carried by a U-shaped member 16 to the yoke portion of which it is secured in any suitable manner as by means of screws or bolts 17. The member 16 is pivotally secured to the member 1 at the same diametrically-opposed points at which the member 11 is pivoted. The members 11 and 16 may be mounted on the same trunnions 11' carried by the member 1. As shown, the ends of the legs of the member 16 are connected together by a member 19.

When the parts are in the position shown in Fig. 1, gravity holds the electrode portion 15 in the position in which it projects through the left-hand side of the wall member 1 as

R. FLEMING & C. A. B. HALVORSON, JR.

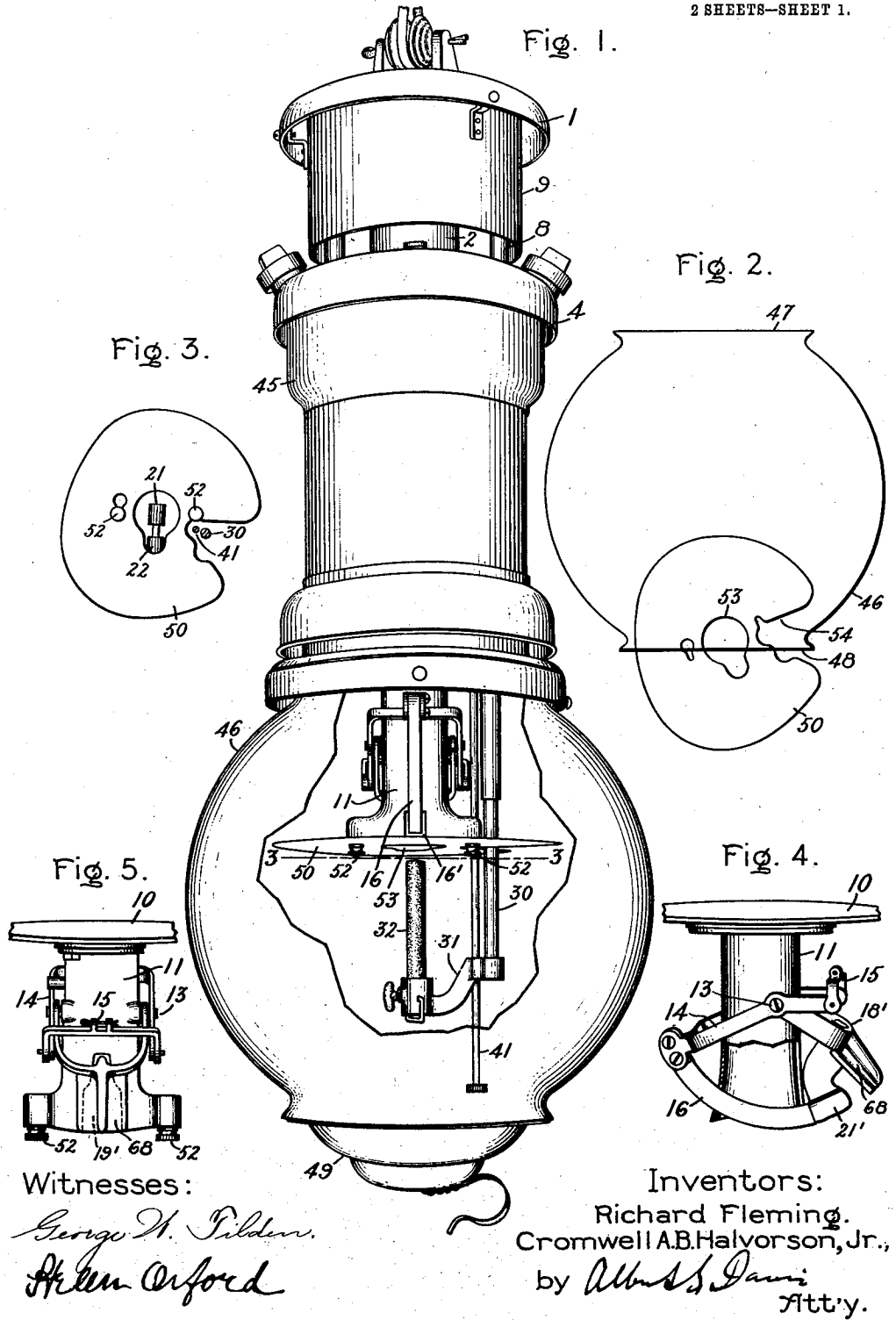
ARC LAMP.

APPLICATION FILED MAY 16, 1904.

901,529.

Patented Oct. 20, 1908.

2 SHEETS—SHEET 1.



Witnesses:  
*George W. Tilden.*  
*Allen Orford*

Inventors:  
Richard Fleming.  
Cromwell A. B. Halvorson, Jr.,  
by *Albert S. Davis*  
Att'y.

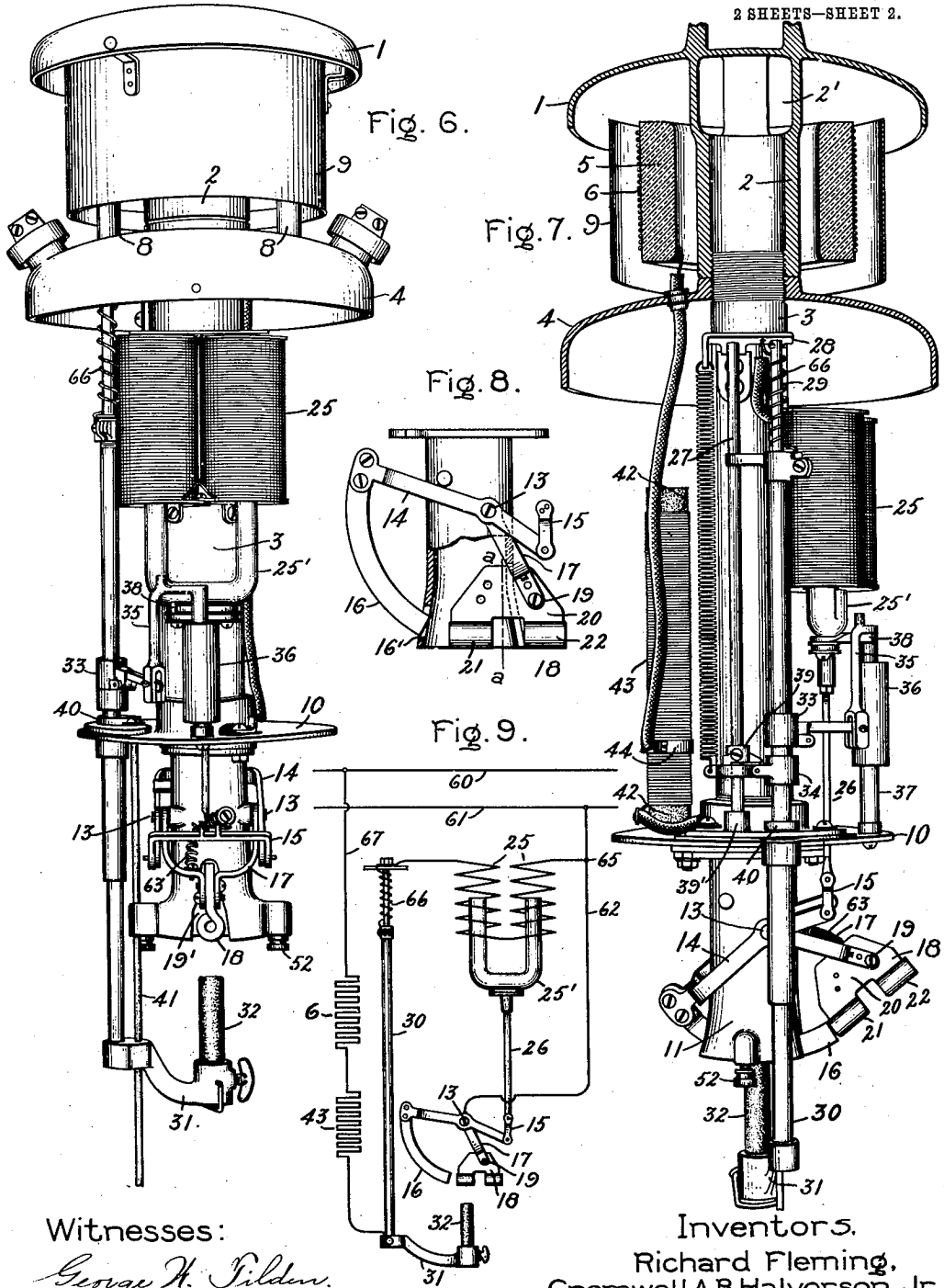
R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED MAY 16, 1904.

901,529.

Patented Oct. 20, 1908.

2 SHEETS—SHEET 2.



Witnesses:  
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# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 901,529.

Specification of Letters Patent.

Patented Oct. 20, 1908.

Application filed May 16, 1904. Serial No. 208,125.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, Jr., citizens of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

Our present invention relates to arc lamps, particularly of that character described in an application for patent on arc lamps filed by us November 16, 1903, the serial number of which is 181,332. In the arc lamp shown in detail in that application the illumination comes largely from the arc between a consuming negative electrode and a non-consuming positive electrode, suitable provisions being made for starting and regulating an arc between the electrodes and for disposing of the products of combustion of the arc.

While the lamp which we have hereinafter described in detail is of the same general character as the one described and illustrated in the application referred to, it differs in some respects and comprises important improvements in construction and operation over the lamp described in the above-noted application.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. The invention itself may be better understood, however, by reference to the accompanying description and drawings in which we have described and illustrated embodiments of our present invention.

Of the drawings, Figure 1 is a perspective view showing an arc lamp embodying our present invention with a portion of the globe broken away; Fig. 2 is a view showing the method of inserting a reflector in the lamp globe; Fig. 3 is a reduced section taken on the line 3-3 of Fig. 1 looking upward; Fig. 4 is an elevation with parts broken away and in section showing one form of upper electrode and support; Fig. 5 is a view taken at right angles to Fig. 4; Fig. 6 is a perspective view of the lamp with the casing and globe removed; Fig. 7 is a view similar and taken at right angles to Fig. 6 with parts in section; Fig. 8 is an elevation showing the form of upper electrode and support used in the lamp shown in Figs. 1, 6 and 7; and Fig. 9 is a dia-

gram illustrating the circuit arrangement of 55  
the lamp.

In the drawings, 1 represents a cap or hood which is provided with a centrally located tubular member 2 threaded interiorly at its lower end to receive one end of the tubular 60  
member 3. The upper end of the member 3 also has threaded upon it a hood 4. A bushing 5 which may be formed of porcelain or other suitable insulating and refractory material surrounds the member 2 and carries 65  
on its outer periphery a resistance conductor 6. The bushing 5 is supported by posts 8 from the hood member 4, and is surrounded by a casing 9 which is supported from the hood member 1 but is separated therefrom 70  
somewhat. Apertures 2' are formed in the upper end of the member 2 through which gases may pass from member 2 into the outside air above the bushing 5 and casing 9. The bushing 5 is separated from the member 2 and 75  
from the casing 9 by spaces through which air may circulate. To increase this circulation a space is left between the lower end of the casing 9 and the top of the hood member 4. 80

The lower end of the member 3 carries, preferably by a threaded connection, a disk-shaped platform 10. A tubular member 11 is secured against but insulated from the lower side of the platform 10. Screws 13 85  
threaded into bosses or lugs formed on the opposite sides of the member 11 pivotally support a pair of members 14. One end of each member 14 is pivotally connected to a yoke member 15. One end of an arc shaped- 90  
bar 16, of some conducting material such as wrought copper, is secured between the other ends of the member 14. The other end of the bar 16 normally substantially closes a slot 16' 95  
in the wall of the member 11.

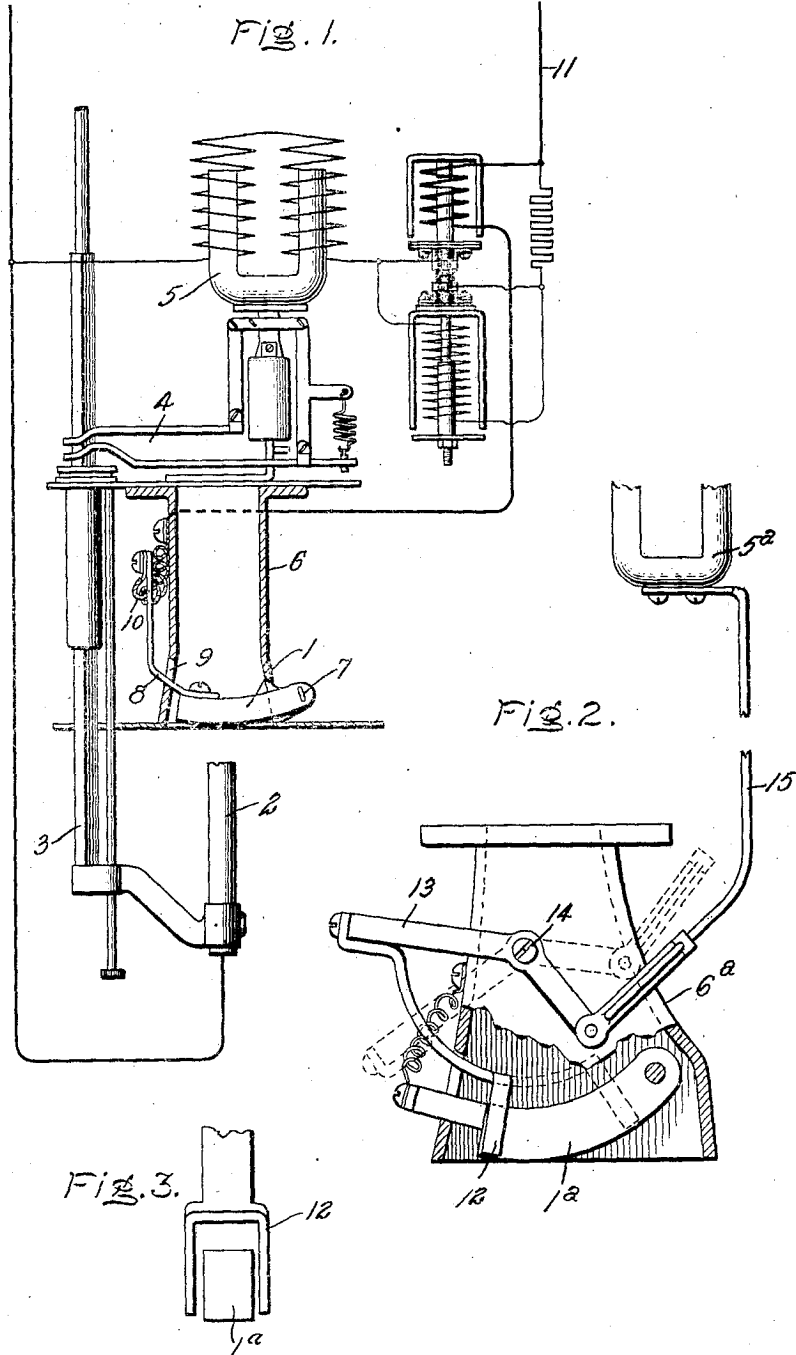
The bar 16 forms the starting portion of the positive electrode of the lamp. The screws 13 also pivotally support a pair of members 17. A member 18 is clamped between the members 17 by screws 19. The 100  
member 18 which forms the working portion of the positive electrode is formed of some conducting material not readily oxidized at comparatively high temperatures, such as wrought copper, and comprises a flat portion 105  
20 and two extensions 21 and 22 which may be stamped or punched into shape. The extensions 21 and 22, which are similar to each



C. A. B. HALVORSON, JR.  
 ARC LAMP.  
 APPLICATION FILED OCT. 31, 1906.

905,514.

Patented Dec. 1, 1908.



WITNESSES:  
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*Walter Orford*

INVENTOR:  
 Cromwell A. B. Halvorson Jr.,  
 By *Albert B. Davis*  
 Att'y.

# UNITED STATES PATENT OFFICE.

CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 905,514.

Specification of Letters Patent.

Patented Dec. 1, 1908.

Application filed October 31, 1906. Serial No. 341,409.

To all whom it may concern:

Be it known that I, CROMWELL A. B. HALVORSON, Jr., a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention relates to electric lamps of the type employing electrodes of such a character that a flaming or luminous arc is obtained.

It is customary to use a non-consuming positive electrode made of copper or some other good conductor of electricity and heat. As the negative electrode is consumed fumes are given off and these condense more or less on the positive electrode, forming thereon an objectionable coating which, if not removed, interferes with the successful operation of the lamp.

The present invention contemplates means for preventing the formation of any considerable coating by periodically removing such material as may be deposited upon the electrode.

To this end my invention comprises a novel construction and arrangement of parts to be hereinafter particularly pointed out in the claims. For a full understanding of my invention, however, and of its objects and advantages reference may be had to the following detailed description taken in connection with the accompanying drawing.

In said drawing, Figure 1 shows conventionally a lamp and the circuit connections thereto, the positive electrode being pivotally supported in accordance with one modification of my invention; Fig. 2 is a side elevation of a chimney within which a positive electrode is supported, together with an auxiliary cleaning device for said electrode, a portion of the wall of the chimney being broken away to more clearly show the electrode and cleaning device; and Fig. 3 is an end view of the electrode and a portion of the cleaning device shown in Fig. 2.

The lamp shown in Fig. 1 of the drawing is, with the exception of the positive electrode, identical with that disclosed in an application, Serial No. 296,304, filed by Richard Fleming and myself on the 16th day of January, 1906; but it will, of course, be understood that my invention is applicable to any form of luminous arc lamp and

is not confined to the particular lamp illustrated.

Referring to the drawing, 1 and 2 are the positive and negative electrodes, respectively. The electrode 2 is of any usual kind supported upon a rod or tube 3 and being fed in the usual manner by clutch mechanism 4 controlled by an electromagnet 5. All these parts, with the exception of the positive electrode, may take any usual forms and need therefore not be described in detail.

6 is a chimney arranged in line with and above the negative electrode and is adapted to carry away the fumes.

According to my invention the positive electrode 1 is pivoted to the chimney so that when the negative electrode is brought up against it in starting or in feeding, the positive electrode is oscillated through a limited distance and any material which may have been deposited thereon is dislodged. The form of the positive electrode and the manner of movably supporting it in the path of the negative electrode may be varied, but the electrode may conveniently consist of a bar extending transversely of the chimney and pivoted at one end, as at 7, to some part of the chimney. The free end of the electrode, or a part 8 secured thereto, may extend through an elongated slot 9 in the opposite wall of the chimney, whereby the electrode, while supported at both ends after the arc is struck, is free to swing through a limited angle determined by the length of the slot. The member 8 may conveniently serve as the terminal to which a lead 10, connected to the positive side of the line 11, is secured. This lead may be in electrical engagement with the chimney so that current may also flow to the positive electrode through the chimney and the pivot upon which the electrode is supported. It will be seen that whenever the lower electrode is raised, the positive electrode will be swung about its pivot and the member 8 caused to strike against the upper end of the slot. When the negative electrode is again lowered to the operative position, the positive electrode drops until the member 8 strikes the lower wall of the slot and the electrode then remains in that position until the next feeding operation takes place. The jarring of the electrode produced by this succession of blows causes

any deposit to be loosened and to drop away.

In Fig. 2 there is shown a further modification wherein the jarring action upon the positive electrode is assisted by a mechanical scraping device. The electrode 1<sup>a</sup> may be similar to the electrode 1, being pivoted at one side of the chimney 6<sup>a</sup>. 12 is a fork which embraces the electrode 1<sup>a</sup>; this fork being supported upon one end of a bell crank lever 13 pivoted to the chimney at 14, and being adapted, when the lever is rocked from the position shown in full lines to the position shown in dotted lines, to scrape along the sides of the electrode and remove therefrom any foreign substance which may have collected thereon. The bell crank lever may be operated in any suitable manner; the operation being conveniently effected by means of a rod 15 connected to the core 5<sup>a</sup> of the main regulating magnet, so that, whenever the lamp is started or the lower electrode is fed, the scraper is operated across the electrode in the manner described.

While I have illustrated and described in detail the best forms of my invention known to me, it will be evident that the cleaning of the positive electrode may be carried out in various ways and that therefore my invention, in its broadest aspects, is not limited to the particular construction and arrangement of parts shown.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an arc lamp, a pendulously support-

ed electrode, stops in the path of the oscillatory movements of that electrode, a second electrode, and means for operating the latter electrode to strike the first named electrode to oscillate the same between and into forcible contact with the stops.

2. In an arc lamp, a pendulously supported positive electrode and a negative electrode, means for actuating the latter to oscillate the former, a scraper, and means for moving said scraper across the surface of the positive electrode while the same oscillates.

3. In an arc lamp, positive and negative electrodes, a scraper, an electromagnet for actuating the negative electrode to strike and oscillate the positive electrode, and a connection between said electromagnet and said scraper for causing the latter to move across the surface of the positive electrode when the negative electrode is actuated.

4. In an arc lamp, a positive electrode having a limited movement out of its normal position, a negative electrode, a scraper, and means for operating said negative electrode to cause it to strike the positive electrode and carry it out of its normal position and for moving the scraper across the surface of the positive electrode.

In witness whereof, I have hereunto set my hand this 30th day of October, 1906.

CROMWELL A. B. HALVORSON, JR.

Witnesses:

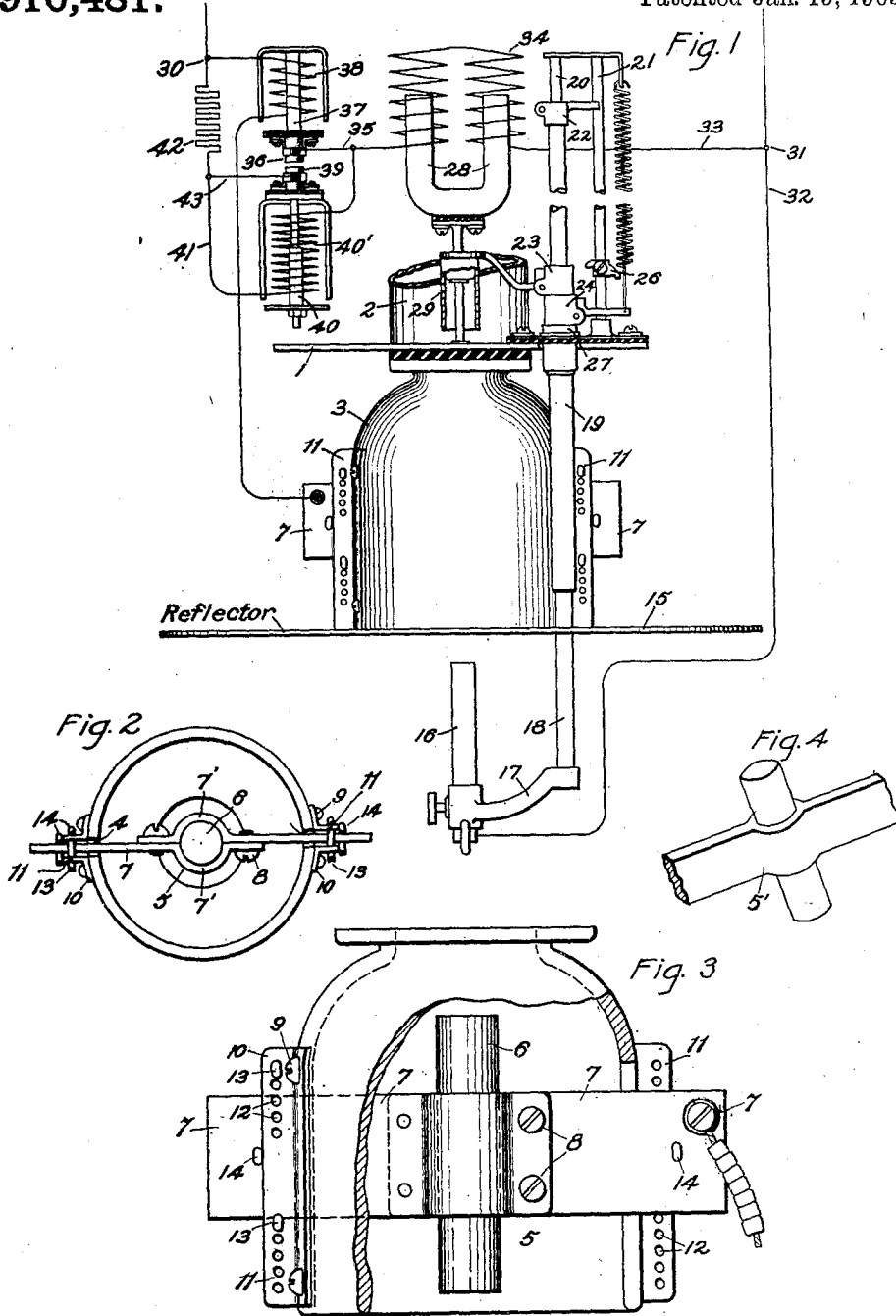
BENJAMIN B. HULL,  
HELEN ORFORD.

R. FLEMING.  
ARC LAMP.

APPLICATION FILED DEC. 28, 1905.

910,481.

Patented Jan. 19, 1909.



Witnesses:  
Margaret C. Stoolley  
William Alfred

Inventor  
Richard Fleming  
By Albert H. Davis  
Att'y

# UNITED STATES PATENT OFFICE

RICHARD FLEMING, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 910,481.

Specification of Letters Patent.

Patented Jan. 19, 1909.

Application filed December 28, 1905. Serial No. 293,590.

*To all whom it may concern:*

Be it known that I, RICHARD FLEMING, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention relates to arc lamps of that type in which the character of the electrodes employed is such that a flaming or luminous arc is obtained. With such electrodes the major portion of the light furnished by the lamp comes directly from the arc itself and not from the electrode tips heated to incandescence as is the case with the ordinary arc lamp employing carbon electrodes.

It has been found that in direct current flaming or luminous arc lamps no consumption of the positive electrode from the action of the arc is necessary. Otherwise stated, any consumption of the positive electrode occurring is incidentally due to heat oxidation, supplemented perhaps in some instances by a chemical interaction between the electrode and the arc gases and is not necessary to the maintenance of the arc.

My present invention consists in features of construction and arrangement of the non-consuming positive electrode of a luminous or flaming arc lamp and of the fume box or hood which surrounds the electrode and serves as a conduit for carrying away the gaseous arc products which, differing from the arc products from a carbon arc, contain considerable amounts of material which does not exist in a gaseous form at ordinary atmospheric temperatures.

In carrying out my invention I have arranged the positive electrode so that it may be readily adjusted to compensate for any incidental consumption or deterioration produced in operation and so that while normally in a fixed position it may be moved therefrom in the feeding operation of the lamp to dislodge material condensed upon it from the arc products.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated somewhat dia-

grammatically one of the forms in which my invention may be embodied.

Of the drawings, Figure 1 is a combined diagram and partial elevation of an arc lamp equipped with my invention; Fig. 2 is an inverted plan of the fume box showing the positive electrode and its supports; Fig. 3 is an elevation partly broken away and in section showing the construction of one form of positive electrode and fume box; and Fig. 4 is a perspective view illustrating a different form of electrode.

In the drawings, 1 represents a platform secured in any suitable manner to the arc lamp framework. For instance, the platform 1 may be secured to the lower end of the chimney member 2 forming the backbone of the arc lamp structure as described in an application for patent filed jointly by Cromwell A. B. Halvorson, Jr. and myself on the 16th day of November, 1903, Serial No. 181,332. To the underside of the platform 1 is secured in any suitable manner a bell or inverted cup-shaped fume box or hood 3. Preferably the fume box 3 is insulated from the platform 1. The upper end of the fume box which is open communicates with the chimney member 2 of which it may be regarded as an extension. Vertically extending diametrically opposed slots 4 are formed in the member 3 extending from the lower end of the member to the upper end of the cylindrical portion thereof.

The upper and positive electrode 5 comprises a rod or bar like portion 6 formed of copper or other metal having good heat and electrical conducting properties which is supported in line with the axis of the members 1 and 2 by means of wing like portions or extensions 7 which project through the slots 4. Each extension 7 in the construction shown in Figs. 1, 2 and 3 consists of a strap or bar of metal such as copper or brass having good electric and heat conductivity, and is formed with a semicircular bow portion 7' adjacent one end. As shown, the parts are assembled so that the bow portions unite to form an annular support in which the rod or bar 6 is clamped. Screws 8 are employed for clamping the two extensions 7 together.

Against the outer surface of the member 3 are secured by screws 9 four members 10 which may be formed of sheet metal and be substantially L-shaped in cross-section. As

shown, the members 10 are secured one at each side of each slot 4 with the side 11 of each member adjacent the corresponding slot extending parallel to the plane including the slots. Registering apertures 12 are formed in each pair of adjacent members 10 through which cotter pins 13 may be passed. As shown, one pair of cotter pins 13 are employed to support the electrode 5 and another pair of cotter pins 13 are employed to limit the upward movement of the electrode 5 produced in a manner hereinafter described. The cotter pins 14 which pass through the extensions 7 serve as stops engaging the outer edges of the member 10 to prevent the rod-like portion 6 from moving out of its axial position with respect to the member 3. A disk-like reflector 15 may be secured to the lower end of the member 3 in any suitable manner.

In the form of my invention disclosed, the lower electrode 16 may be in the form of a pencil composed of or containing some material giving a flaming or luminous arc, such as magnetite, titanium oxid, titanium carbide, or the like. The pencil 16 is supported in a socket formed in an arm 17 carried by the lower end of a tubular member 18. The member 18 slides within a member 19 secured to the platform 1 and slides upon a rod-like member 20. The member 20 is supported from a post 21 carried by the platform 1. A guide 22 carried by the member 18 and engaging the post 21 prevents angular displacement of the member 18. Above the platform 1 the member 18 is surrounded by the yoke members of an upper clutch 23 and a lower clutch 24. The pawl member of the clutch 24 is normally held in position in which the member 18 is locked between it and its cooperating yoke member by means of a long helical spring 25. The movement of the clutch 24 is limited by an adjustable upper stop 26 and a lower stop 27. The pawl member of the clutch 23 is connected to an armature 28. The armature 28 is also connected to a dash-pot 29. The dash-pot 29 is arranged to retard the downward movement of the armature 28 without hindering the upward movement of the armature.

In the diagrammatic portion of Fig. 1, 30 represents the positive terminal of the arc lamp and 31 the negative terminal. A conductor 32 connects the terminal 31 to the electrode 16. A conductor 33 connects the terminal 31 to one terminal of the winding 34 cooperating with the armature 28. The other terminal of the winding 34 is connected by a conductor 35 to a contact 36 carried by a movable armature 37. The winding 38 cooperating with the armature 37 is connected in series between the positive terminal of the lamp 30 and the electrode 5. A contact member 39 cooperating with the contact member 36 is carried by the movable armature 40 of an electromagnet, one ter-

minal of the winding 40' of which is connected to the conductor 35, and the other terminal of which is connected to the lamp terminal 30 by a conductor 41, and a resistance conductor 42. The contact member 39 is connected to the conductor 41 by a conductor 43.

In the running position of the lamp, which is that shown in the diagram, the winding 38 which is in series with the arc between the electrodes, is energized and holds the contact member 36 in a position in which it is normally out of engagement with the contact member 39.

When the lamp is in the out-of-service condition, the contact member 36 drops into engagement with the member 39. When thereafter the lamp terminals 30 and 31 are operatively connected into a supply circuit, current will flow between the terminals 30 and 31 through the resistance 42, conductor 43, contacts 39 and 36, conductor 35, winding 34 and conductor 33. This operatively energizes the winding 34 and causes the armature 28 to be elevated. As the armature 28 moves upward the member 18 is moved with it by means of the clutch 23 until the electrode 16 first engages the electrode 5 and then moves it to the position in which it engages the upper cotter pins 13. During the upward movement of the member 18, the clutch 24 moves with it until the pawl arm of the clutch engages the upper stop 26 after which further upward movement of the member 18 takes place without a corresponding movement of the clutch 24.

As soon as current begins to flow between the electrodes the winding 38 becomes operatively energized and attracts the armature 37, thus separating the contact members 36 and 39 whereupon the winding 34 will no longer be operatively energized, the resistance of the winding 40' being too great to allow passage through it of the energizing current for the winding 34. The armature 28 and the member 18 will then begin to descend. As soon as the electrode 5 engages the lower pair of cotter pins the electrode 16 will move out of engagement with the electrode 5 thus drawing an arc. The downward movement of the member 18 and thereby the length of the arc between the electrodes is limited by the engagement of the yoke member of the clutch 24 with the lower stop 27.

After an arc is once drawn it is ordinarily maintained until the lamp is cut out of circuit or until the arc voltage is increased beyond a predetermined maximum by reason of the increase of arc length or other cause. When the voltage increases to the predetermined maximum the current flowing through the winding 40' becomes great enough to attract the armature 40 and move the contact member 39 into engagement with the con-

tact member 36. When this occurs the winding 34 is once more operatively energized and the feeding operation of the lamp is repeated. At each feeding operation of the lamp an arc is struck of a fixed length equal to the difference between the play of the clutch 24 between the stops 26 and 27 and the play of the electrode 5 between the upper and lower cotter pins 13.

As the winding 34 is relatively powerful and as the upward movement of the armature 28 is not impeded by the dash-pot 29 the electrode 16 is moved rapidly upward at each feeding operation. As a result the electrode 5 is given two blows by the electrode 16 at each feeding operation,—first when the electrode 16 engages the electrode 5, and secondly when the electrode 5 engages the upper cotter pin. As a result, solid material condensed from the gaseous arc products upon the electrode 5 are dislodged at each feeding operation. This prevents a choking up of the member 3 and insures good contact between the electrodes 16 and 5.

While practically speaking the electrode 5, if suitably proportioned and arranged, dissipates heat so rapidly by direct radiation and by conduction to the members 7 and thence to the hood 3 and by radiation from the members 7 and hood 3 that it is practically indestructible in the normal operation of the lamp, yet the arcing end of the electrode 5 may deteriorate in time from improper operation of the lamp or other cause. The construction shown permits a ready removal of the electrode 5 to permit its arcing ends to be smoothed or faced off in case it is roughened or otherwise injured. Moreover, since either end of the pencil 6 may be used as the arcing end, the ends of the pencil may be reversed when desirable so that the pencil need not be faced off until both ends are roughened or otherwise rendered defective. To reverse the ends of the member 6 it is not necessary to remove the member 6 from its supporting wings since the latter can be reversibly placed in the slots 4. To adjust the up and down position of the member 6 in the fume box 3 to compensate for whatever length of pencil 6 may be employed, it is only necessary to shift the position of the cotter pins 13 in the holes formed to receive them. By varying the distance between the upper and lower cotter pins 13 the play of the electrode 5 can be adjusted.

Instead of forming the upper and positive electrode of the lamp as shown in Figs. 1, 2 and 3 inclusive, I prefer in some instances to form the electrode and supporting wings of a single integral piece of forged copper or similar metal shown in Fig. 4 having the same general form as the construction shown in Figs. 1, 2 and 3.

It will of course be understood that in the lamp as actually constructed suitable means

are employed for inclosing and supporting the feeding mechanism above the platform 1 and a suitable inclosing transparent or translucent globe may be employed beneath the platform 1 to protect the arc between the electrodes.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. As an article of manufacture, an arc lamp electrode formed as a rod having a number of supporting wings projecting laterally therefrom.

2. As an article of manufacture, an arc lamp electrode formed as a rod having a number of supporting wings projecting laterally therefrom at right angles to its axis.

3. As an article of manufacture, a reversible arc lamp electrode, formed as a rod having a number of supporting wings projecting laterally therefrom between its ends.

4. As an article of manufacture, a reversible arc lamp electrode, formed as a rod with a number of supporting wings projecting laterally therefrom between its ends and at right angles to its axis.

5. As an article of manufacture, a non-consuming arc lamp electrode, composed of a rod of metal that is a good conductor of heat, and having a number of supporting wings of like metal with large heat radiating surfaces, said wings projecting laterally from the rod.

6. As an article of manufacture, a non-consuming arc lamp electrode, composed of a rod of metal that is a good conductor of heat, and having a number of supporting wings of like metal extending at right angles to the axis of the rod, said wings having large heat radiating surfaces.

7. As an article of manufacture, a non-consuming reversible arc lamp electrode, composed of a rod of metal that is a good conductor of heat and having a number of supporting wings of like metal extending laterally therefrom between the ends of the rod.

8. As an article of manufacture, a non-consuming reversible arc lamp electrode, composed of a rod of metal that is a good conductor of heat, and having a number of supporting wings of like metal extending laterally therefrom between the ends thereof and at right angles to its axis.

9. In an arc lamp, the combination of a fume box open at both ends, having slots parallel with and on opposite sides of its axis, with an electrode rod having supporting wings extending laterally therefrom and loosely into the slots, so as to be movable therein, and stops transversely to the slots for supporting the electrode.

10. In an arc lamp, the combination of a fume box open at both ends, having slots parallel with and on opposite sides of its axis, with an electrode rod having supporting wings extending laterally therefrom and loosely into the slots so as to be movable

therein, and stops transversely to the slots for supporting the electrode, and like stops for limiting the upward movement of the electrode.

5 11. In an arc lamp, the combination of a fume box open at both ends and having slots parallel with its axis, with an electrode in axial alinement with the fume box having wings extending into said slots, and adjustable stops for supporting the electrode, and  
10 adjustable stops for limiting the upward movement of the electrode.

12. In an arc lamp, the combination of a fume box open at both ends and terminating  
15 below with a cylindrical portion having two diametrically opposite vertical slots opening into the lower edge of the fume box, with an electrode rod having two wings extending laterally therefrom and freely into the slots  
20 so as to be movable therein, and adjustable stops for limiting the movement of the electrode in either direction.

13. In an arc lamp having arc controlling mechanism and an electrode controlled by  
25 the same, a fume box formed with slots in it, and a second electrode guided and supported in said slots, said second electrode being dis-

connected from the controlling mechanism but free to have a limited up and down movement in said slots. 30

14. In an arc lamp, a fume box open at both ends and having a cylindrical portion, axially extending slots being formed in said cylindrical portion, a metallic electrode axially supported in said fume box with its arc-  
35 ing end adjacent one end of the box, said electrode provided with wings or extensions extending into said slots, stops or supports for retaining said wings or extensions in said slots, said stops being arranged to permit a  
40 limited axial movement of the electrode with respect to the fume box.

15. In an arc lamp, a fume box having slots formed in it, a metallic electrode located in said fume box and provided with wings ex-  
45 tending into said slots, and adjustable stops carried by the fume box engaging said wings.

In witness whereof, I have hereunto set my hand this 26th day of December, 1905.

RICHARD FLEMING.

Witnesses:

JOHN A. McMANUS, Jr.,  
JOHN J. WALKER.

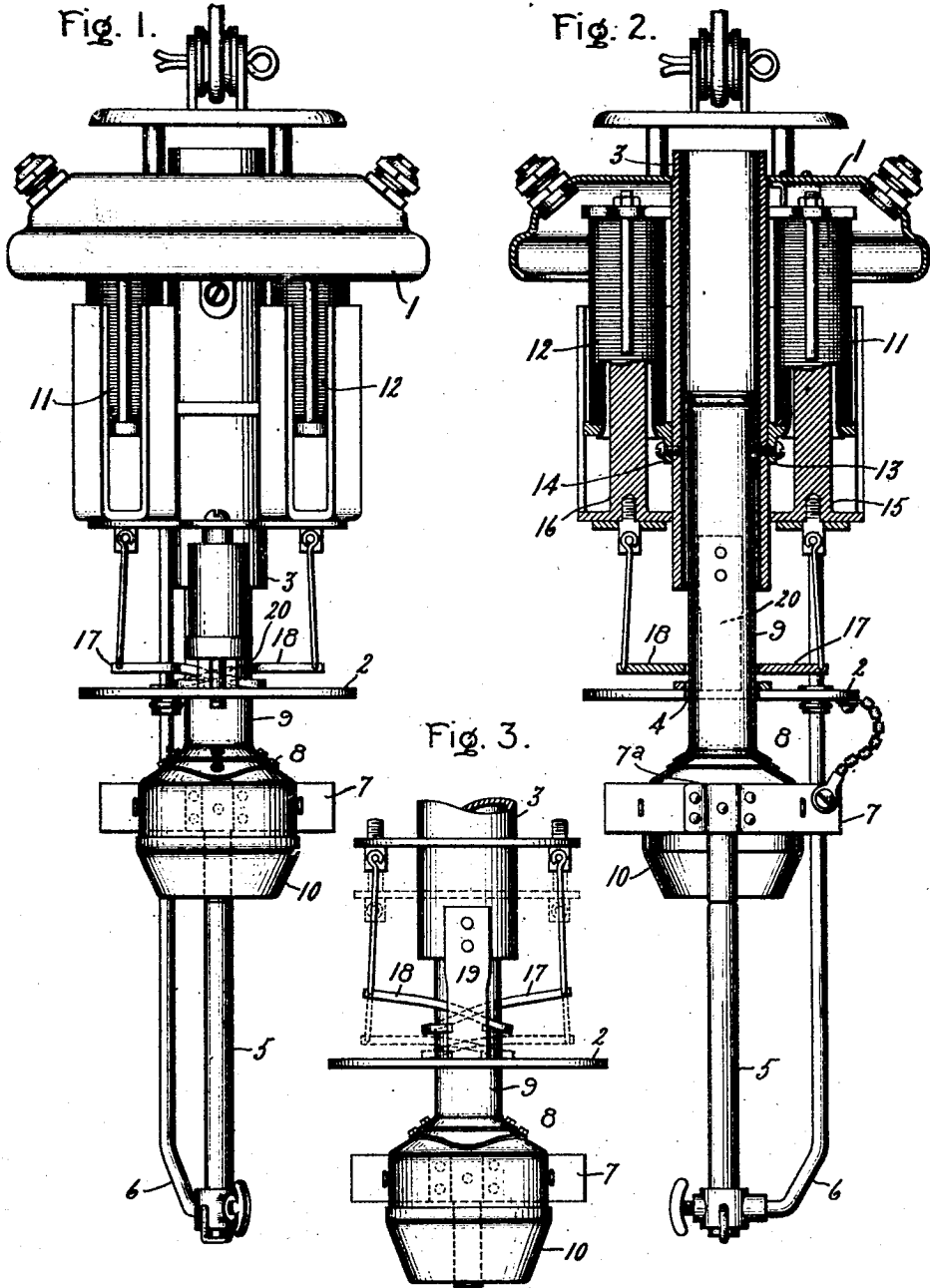


C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED JAN. 16, 1907.

910,670.

Patented Jan. 26, 1909.



Witnesses:  
*George H. Tilden*  
*J. Ellis Ken*

Inventor:  
Cromwell A.B. Halvorson Jr.,  
by *Albert H. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 910,670.

Specification of Letters Patent.

Patented Jan. 26, 1909.

Application filed January 16, 1907. Serial No. 352,523.

*To all whom it may concern:*

Be it known that I, CROMWELL A. B. HALVORSON, Jr., a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention relates to electric arc lamps and has for its object to simplify and improve the construction of the same.

The various features of novelty which constitute my invention will be hereinafter particularly pointed out in the claims.

For a full understanding of my invention, however, and of its various objects and advantages reference may be had to the following detailed description taken in connection with the accompanying drawing, wherein—

Figure 1 shows in side elevation a lamp arranged in accordance with the preferred form of my invention, the globe and casing being omitted for the sake of clearness; Fig. 2 is a longitudinal cross-section of the lamp shown in Fig. 1; and Fig. 3 shows a detail.

The lamp shown in the drawings is of the type wherein one of the electrodes is consuming and the other non-consuming, but it will of course be understood that both of the electrodes may be such that they consume during the burning of the lamp. The lamp frame comprises a hood 1, a platform 2 and a central backbone member 3 which secures the hood and platform together and constitutes the main chimney of the lamp. At its upper end the chimney projects through the hood and at its lower end it registers with an opening 4 in the platform.

5 is a stationary electrode supported beneath the platform of the lamp, in axial alignment with the chimney or draft tube, by means of a holder 6 of any usual or preferred construction. The companion electrode which, in the present instance, is shown as being in the form of a bar 7, arranged transversely to the axis of the lower electrode and having a central cylindrical portion 7<sup>a</sup> axially aligned with the lower electrode, is carried within the lower end of a floating draft-tube or chimney member 8 which is arranged in telescoped relation with the main chimney. This floating chimney preferably consists of a stem 9 having a bell-shaped portion 10 at its lower end. The bell-shaped portion, within which the upper

electrode is mounted, is arranged beneath the platform of the lamp and the stem extends upwards through the opening 4 in the platform and into the lower end of the stationary chimney. The arc gases, it will be seen, pass up through the two chimney members and are discharged at a point above the hood.

The regulating mechanism of the lamp consists of an electromagnet comprising the members 11 and 12 which are supported from the chimney member 3 by means of brackets 13 and 14. The cores and armatures 15 and 16 of these electromagnets are connected respectively to clutches 17 and 18, which are adapted to act upon the floating chimney. In order to permit the application of the clutch mechanism, the stationary chimney is cut away adjacent the platform. This is conveniently accomplished by cutting away the whole lower end of the chimney and connecting it to the platform by means of relatively narrow brackets 19 and 20, which thus become parts of the stationary chimney.

When the lamp is not burning, the floating chimney drops down until the upper electrode rests upon the lower electrode. When the current is turned on, the regulating magnet is energized and, acting through the clutches, lifts the chimney so as to strike the arc. As the lower electrode consumes and the arc grows longer, the regulating magnet is weakened so that the cores gradually drop and feed the chimney downward, whereby a substantially normal arc is maintained. When the chimney is fed downward far enough to cause the clutches to rest upon the platform, or when the arc breaks from any cause, the hold of the clutches upon the chimney is released and the chimney is free to descend until the electrodes are again brought in engagement with each other. If current is then still being supplied to the lamp, the chimney will be picked up again in the manner described. Consequently, the upper electrode and its supporting chimney are fed downward step by step during the feeding operation of the lamp. The stem of the floating chimney is of such length that the upper end thereof does not pass beyond the lower end of the stationary chimney during normal operation.

By my invention, therefore, lamps may be formed in simple and compact form and of

but few parts without impairing the effectiveness of the draft devices or the nicety of feeding and regulation.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. In an arc lamp, a hood, a platform, a central tubular backbone member connecting the hood and platform together and constituting the main chimney of the lamp, a movable auxiliary chimney telescoped within the backbone member, an electrode carried at the lower end of the auxiliary chimney, and clutch mechanism engaging the auxiliary chimney for controlling the position of the latter and of the electrode carried thereby.

2. In an arc lamp, a hood, a platform, a central tubular backbone member connecting the hood and platform together and constituting the main chimney of the lamp, a movable auxiliary chimney telescoped within the backbone member, an electrode carried by the lower end of the auxiliary chimney, and means for engaging the outer face of the latter for controlling its position and that of the electrode.

3. In an arc lamp, a hood, a platform, a

central tubular backbone member connecting the hood and platform together and constituting the main chimney of the lamp, a movable auxiliary chimney in telescoped relation with the main chimney, an electrode carried at the lower end of the auxiliary chimney, a second electrode, and clutch mechanism engaging the outer face of said auxiliary chimney for changing the relative positions of the said electrodes.

4. In an arc lamp, a hood, a platform, a central tubular backbone member connecting the hood and platform together and constituting the main chimney of the lamp, an auxiliary chimney in telescoped relation with the main chimney, an electrode carried at the lower end of the auxiliary chimney, an electromagnet mounted on said main chimney, a clutch device engaging said auxiliary chimney, and a connection between said clutch device and said electromagnet.

In witness whereof I have hereunto set my hand this fourteenth day of January 1907.

CROMWELL A. B. HALVORSON, JR.

Witnesses:

JOHN A. McMANUS, Jr.,  
HENRY O. WESTENDARP.

R. FLEMING & C. A. B. HALVORSON, JR.  
 ELECTRIC ARC LAMP.  
 APPLICATION FILED DEC. 26, 1908.

914,939.

Patented Mar. 9, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

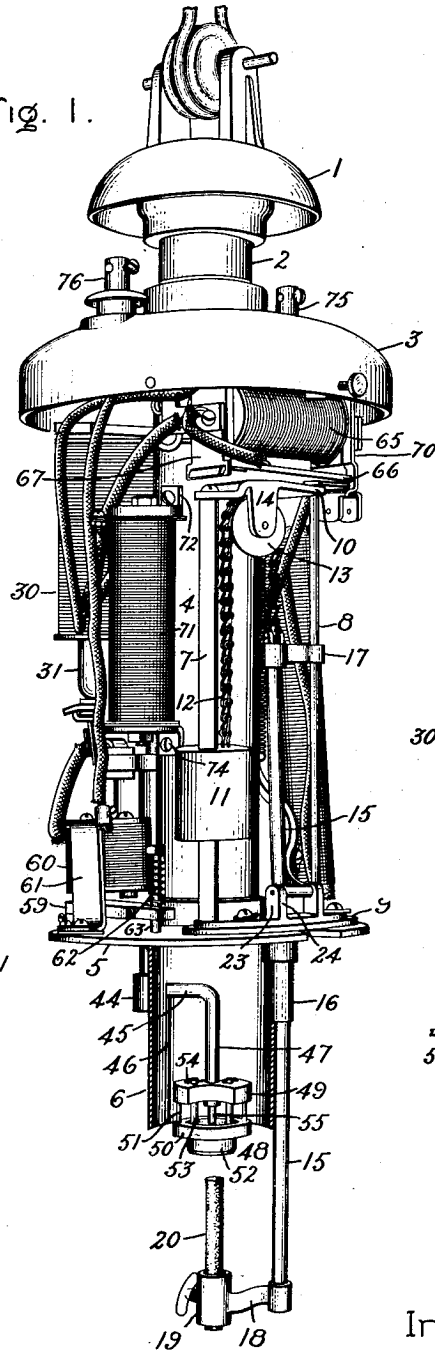


Fig. 2.

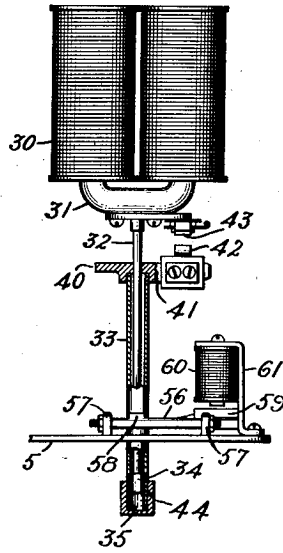
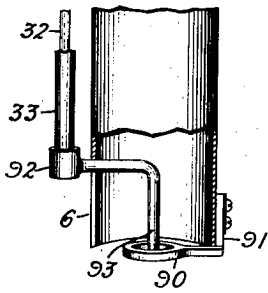


Fig. 3.



Witnesses:

*George H. Tilden.*  
*Helen Orford*

Inventors:

Richard Fleming,  
 Cromwell A. B. Halvorson Jr,

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 Att'y.

R. FLEMING & C. A. B. HALVORSON, JR.  
ELECTRIC ARC LAMP.  
APPLICATION FILED DEC. 28, 1903.

914,939.

Patented Mar. 9, 1909.  
2 SHEETS—SHEET 2.

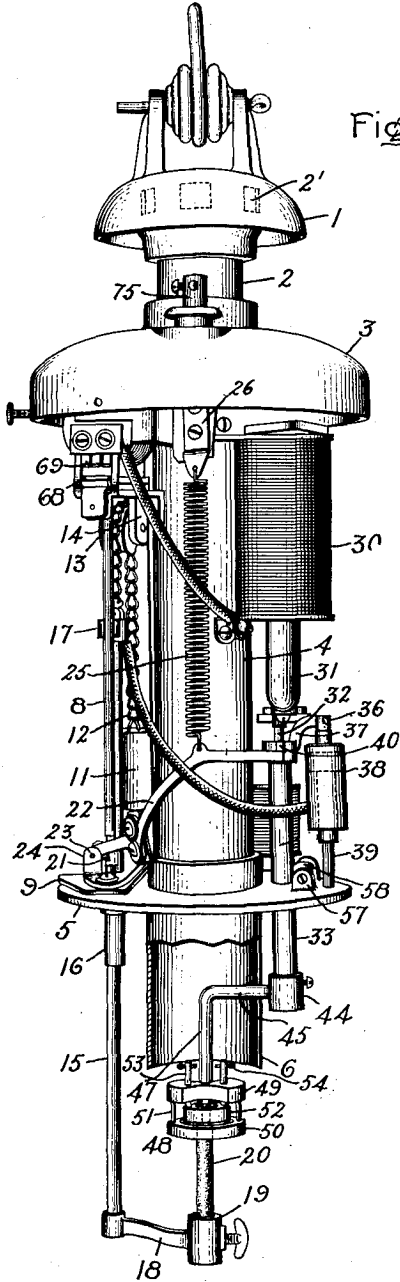


Fig. 4

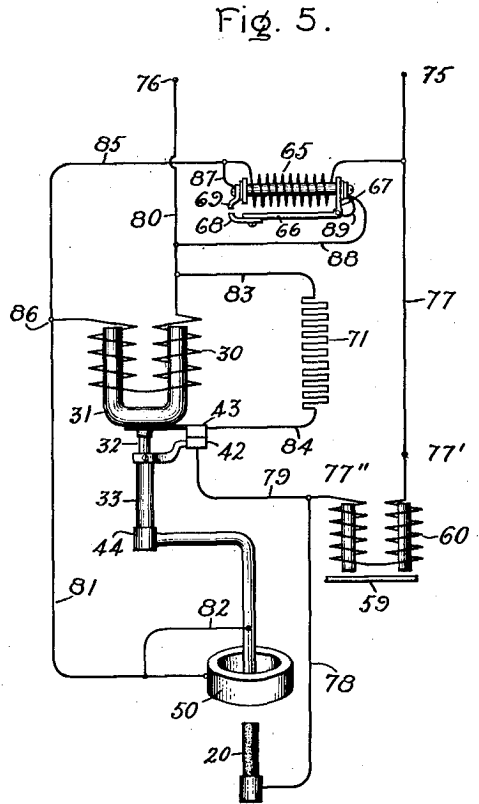


Fig. 5.

Witnesses:  
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*Helen Orford*

Inventors:  
Richard Fleming,  
Cromwell A. B. Halvorson Jr.,  
by *Allen S. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ELECTRIC-ARC LAMP.

No. 914,939.

Specification of Letters Patent.

Patented March 9, 1909.

Application filed December 26, 1908. Serial No. 186,625.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, JR., citizens of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification:

The object of our present invention is to improve the construction and operation of arc lamps.

More particularly our invention relates to arc lamps in which the electrodes employed insure a luminous or flaming arc, which furnishes the major portion of the illumination, rather than to lamps in which one of the electrode tips heated to incandescence furnishes the bulk of the light, as is the case where carbon electrodes are employed. In such lamps it has been found that where in one of the electrodes some suitable material giving a luminous arc such as titanium carbide, titanium oxide, magnetic oxide or iron or certain other materials is employed, the opposite electrode can advantageously be made out of some metal such as copper or the like so constructed and arranged as to be practically non-consumable in the normal operation of the lamp. The arc products or fumes given by some of the materials which may be employed in the consuming electrode to give the luminous arc are apt to deposit more or less upon the exposed parts of the lamp such as the non-consuming electrode and interfere with the proper operation of the lamp unless suitable precautionary steps are taken. The lamp which we have hereinafter described and illustrated in detail is peculiarly adapted to take care of such fumes. The non-consuming electrode which we employ readily cleans itself from time to time of the bulk of any deposit which may be formed upon it. Moreover, as the arc products may form a film on the non-consuming electrode, which is more or less non-conductive when cold, we have provided means by which a cleaning member or part will be caused to engage the non-consuming electrode to start an arc at each feeding operation of the lamp.

Our invention also comprises many novel features in the construction of the feeding mechanism and other parts of the lamp.

The various features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

For a better understanding of our invention reference may be had to the accompanying drawings in which we have illustrated several embodiments of it.

Of the drawings, Figure 1 is a perspective view of the lamp with the casing and globe removed and the parts broken away; Fig. 2 is a partial elevation with parts broken away and showing certain details of construction; Fig. 3 is a partial elevation partly in section showing a modified construction; Fig. 4 is similar to Fig. 1 but taken from a different view point; and Fig. 5 is a diagram illustrating the circuit arrangements of the lamp.

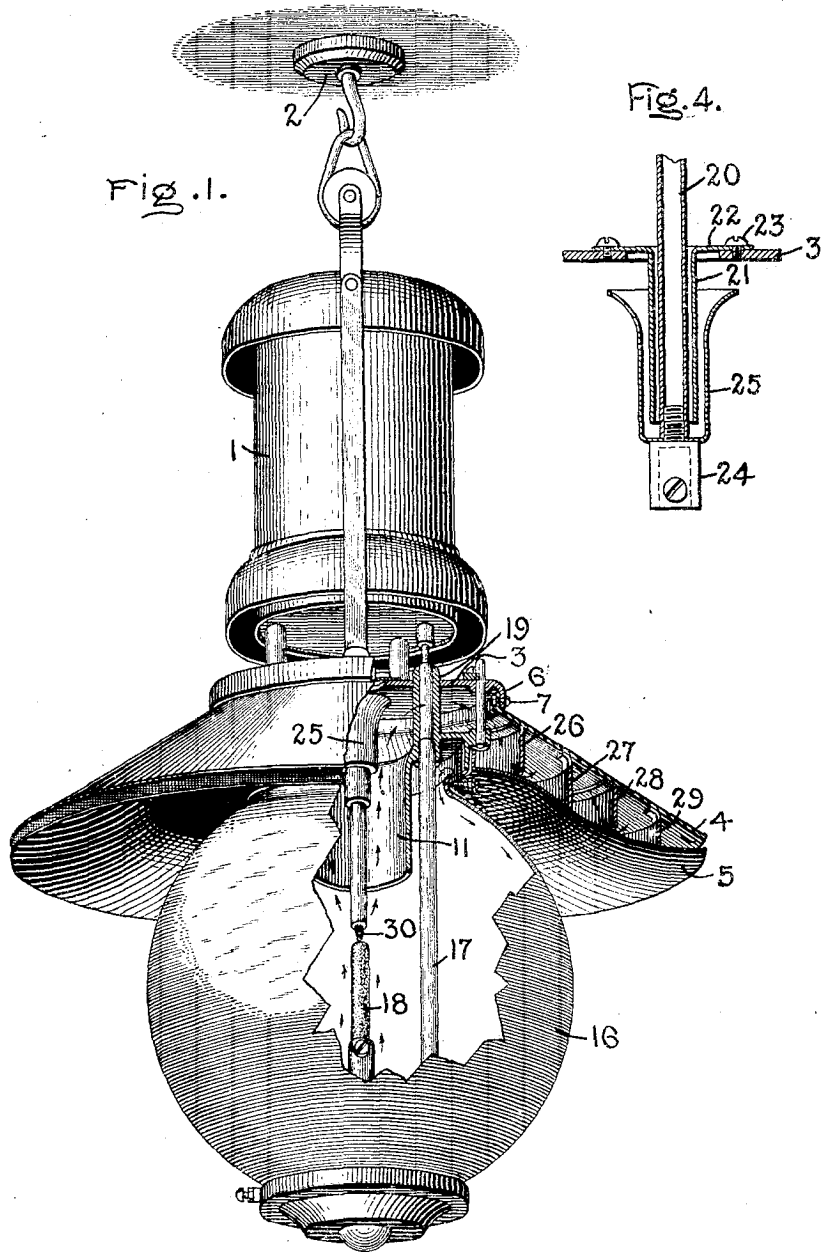
Referring to the drawings, 1 represents a cap or hood from the lower end of which a chimney section 2 extends. The chimney section 2 is formed with discharge openings 2' located within the hood. The lower end of the chimney section 2 carries a cup or hood member 3. A chimney section 4 in alignment and open communication with the chimney section 2 extends from the hood member 3 to a platform 5 which it carries at its lower end. A chimney section 6 extends some distance below the platform 5. The chimney section 6 is in alignment and open communication with the chimney section 4. In fact the chimney sections 2, 4 and 6 are connected together to form a rigid chimney structure and may indeed be integral with each other.

A pair of posts 7 and 8 extend upward from a member 9 which is carried on, but insulated from, the upper side of the platform 5. The upper ends of these posts are secured to a bracket 10 carried by, but insulated from, the chimney section 4. A weight 11 slides on the post 7 which may be rectangular in cross-section to fit a rectangular passage in the weight. To the upper side of weight 11 is secured one end of 100

W. C. FISH & R. FLEMING.  
 ARC LAMP.  
 APPLICATION FILED MAY 29, 1903.

Patented June 15, 1909.  
 2 SHEETS—SHEET 1.

925,166.



Witnesses:

*Erving Plummer*  
*Helen Wford*

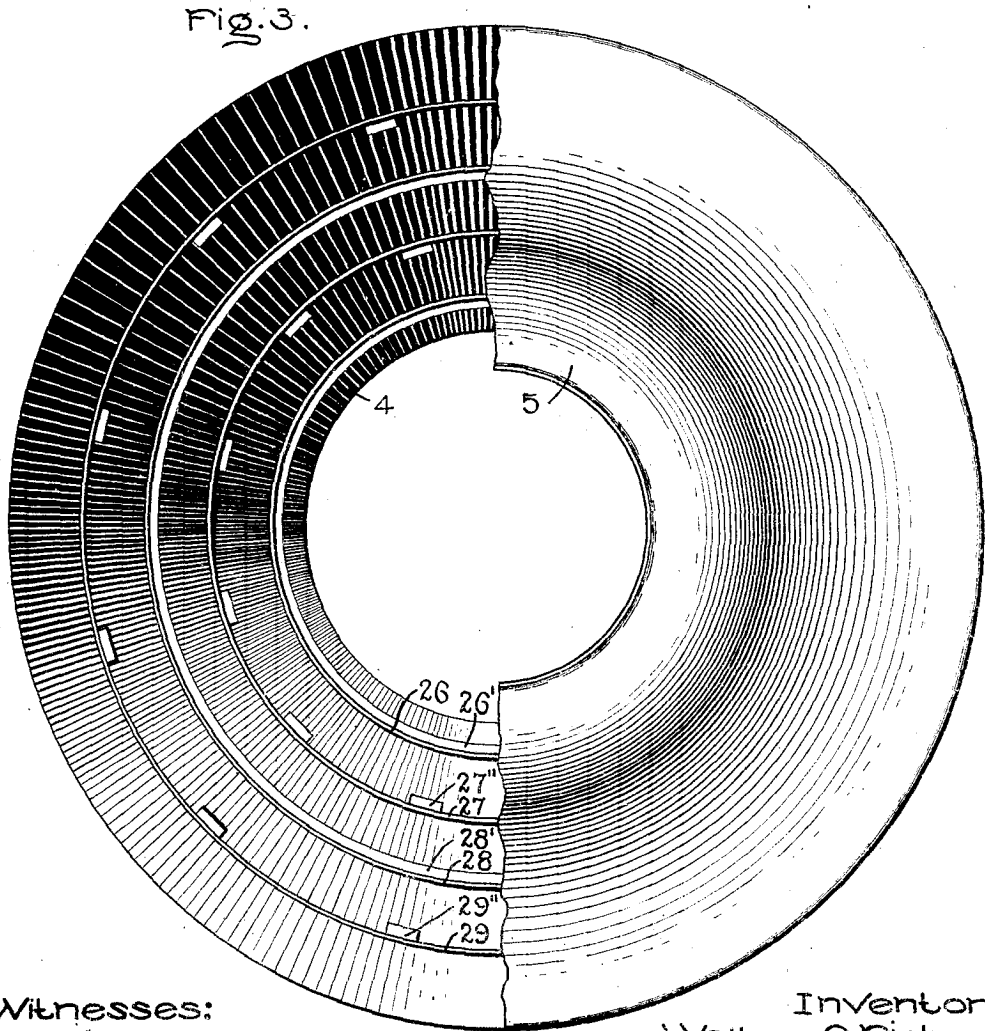
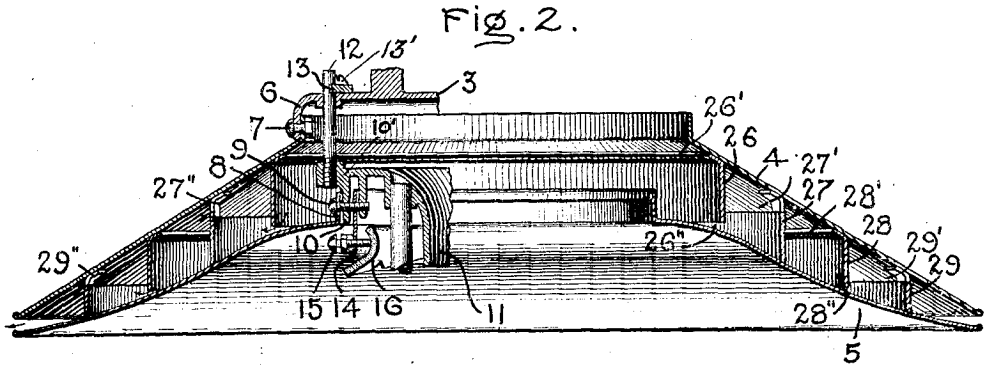
Inventors  
 Walter C. Fish,  
 Richard Fleming,  
 By *Albert H. Davis*  
 Att'y.

W. C. FISH & R. FLEMING.  
 ARC LAMP.  
 APPLICATION FILED MAY 29, 1903.

925,166.

Patented June 15, 1909.

2 SHEETS—SHEET 2.



Witnesses:

*Ewing Sumner*  
*Allen Orford*

Inventors

Walter C. Fish,  
 Richard Fleming

By *Albert H. Davis*  
 Att'y.



# UNITED STATES PATENT OFFICE.

WALTER C. FISH AND RICHARD FLEMING, OF LYNN, MASSACHUSETTS, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 925,166.

Specification of Letters Patent.

Patented June 15, 1909.

Application filed May 29, 1903. Serial No. 159,249.

*To all whom it may concern:*

Be it known that we, WALTER C. FISH and RICHARD FLEMING, citizens of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

In the operation of certain forms of lamps such for instance as those in which luminous or flaming electric arcs are employed as the sources of light, matter is given off by the arc in the form of smoke. Suitable provision for removing the smoke from the lamp is necessary or otherwise solid matter will be deposited from the smoky gases upon the inner surface of the inclosing globe and other portions of the lamp to which it may have access. This is of course objectionable.

To provide means for removing the smoke from the lamp, without at the same time adding materially to the bulk of the lamp, we have constructed a reflector, a necessary part of the lamp, with smoke-carrying passages or channels in it. In the preferred form of our invention this combined reflector and chimney comprises two annular members or parts arranged substantially parallel to one another but separated by a space. The outer surface of one of the annular members, which may be polished, enameled or otherwise treated to smooth it, forms the reflecting surface of the lamp, and the space between the two annular pieces forms a passage for the gases given off by the lamp. The gases enter at the inner edges of the annular pieces and are discharged at or near the outer edges of the annular pieces. Where, as in the lamps designed for indoor use, the discharge of the unpurified gases from the lamp into the outer atmosphere may be objectionable, suitable means may be provided for entrapping some of the impurities in the gases in the space between the two annular parts forming the combined chimney and reflector. One of the ways in which we propose to entrap impurities, contemplates the use of baffle plates suitably arranged to cause a deposit of the heavier impurities within the chimney space.

In order to readily clean and inspect the interior of the combined reflector and chimney, we prefer to make the two parts separable.

In the form of our invention which we

have hereinafter illustrated and described, we have shown a construction in which one of the annular members can be readily removed from the lamp without disturbing the other of said members.

Our invention contemplates other improvements in the lamp, all of which will be pointed out in the claims annexed to and forming a part of this application.

For a better understanding of our invention, reference can be had to the accompanying drawings in which we have illustrated one embodiment of our invention.

In the drawing Figure 1 is an elevation with parts broken away and in section illustrating an arc lamp provided with our combined reflector and chimney; Fig. 2 is a sectional elevation of the combined chimney and reflector; Fig. 3 is a view showing the under side of the reflector shown in Fig. 2 with parts broken away; and Fig. 4 is a sectional elevation illustrating details of the construction of the lamp.

Referring to the drawings, 1 represents an arc lamp suspended from a fixed support at 2. The lamp is provided with a horizontal platform or partition 3 through which the movable upper electrode or mechanism for moving it passes. The combined chimney and reflector as well as the globe are carried from this platform 3.

The combined reflector and chimney comprises a pair of substantially parallel annular pieces or members 4 and 5. Preferably the members 4 and 5 are formed out of sheet metal which may be stamped into the desired form. As is clearly shown in Fig. 2, the members 4 and 5 are both conical but are so shaped that the distance between the inner edges of the members is greater than the distance between the outer edges. The upper member 4 is secured to a down turned flange 6 of the platform 3 in any suitable manner as by bolts 7. The under surface of the lower member 5 which may be polished, painted, enameled, or otherwise treated to give it a polished appearance, forms the reflecting surface of the lamp. At the inner edge of the member 5 an upwardly extending cylindrical flange 8 is formed. Bolts 9 passing through this flange secure the member 5 to a flanged portion 10 which extends downward from the outer periphery of an annular platform member 10'. The platform member 10' which is parallel to but separated

R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED NOV. 16, 1903.

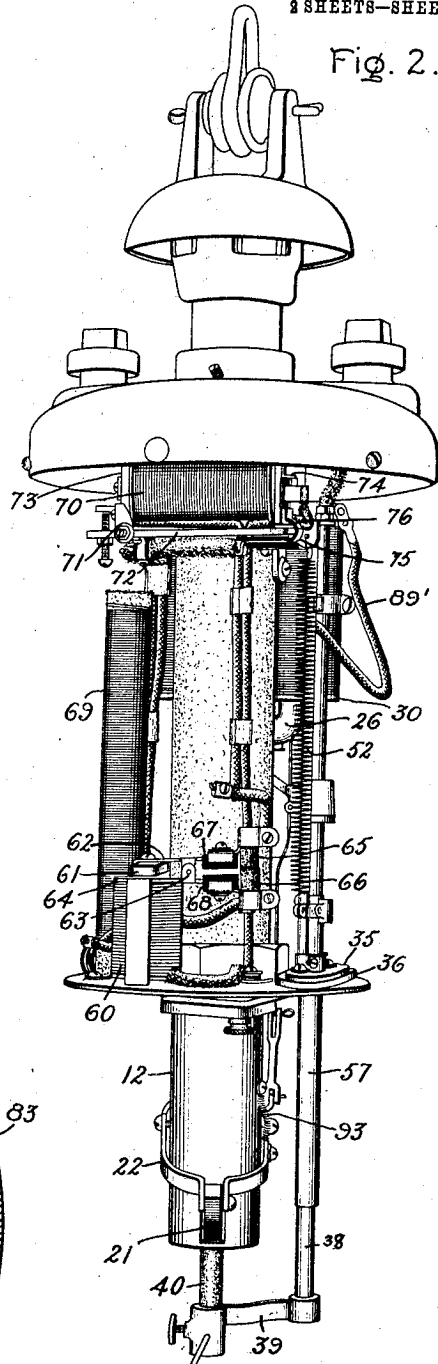
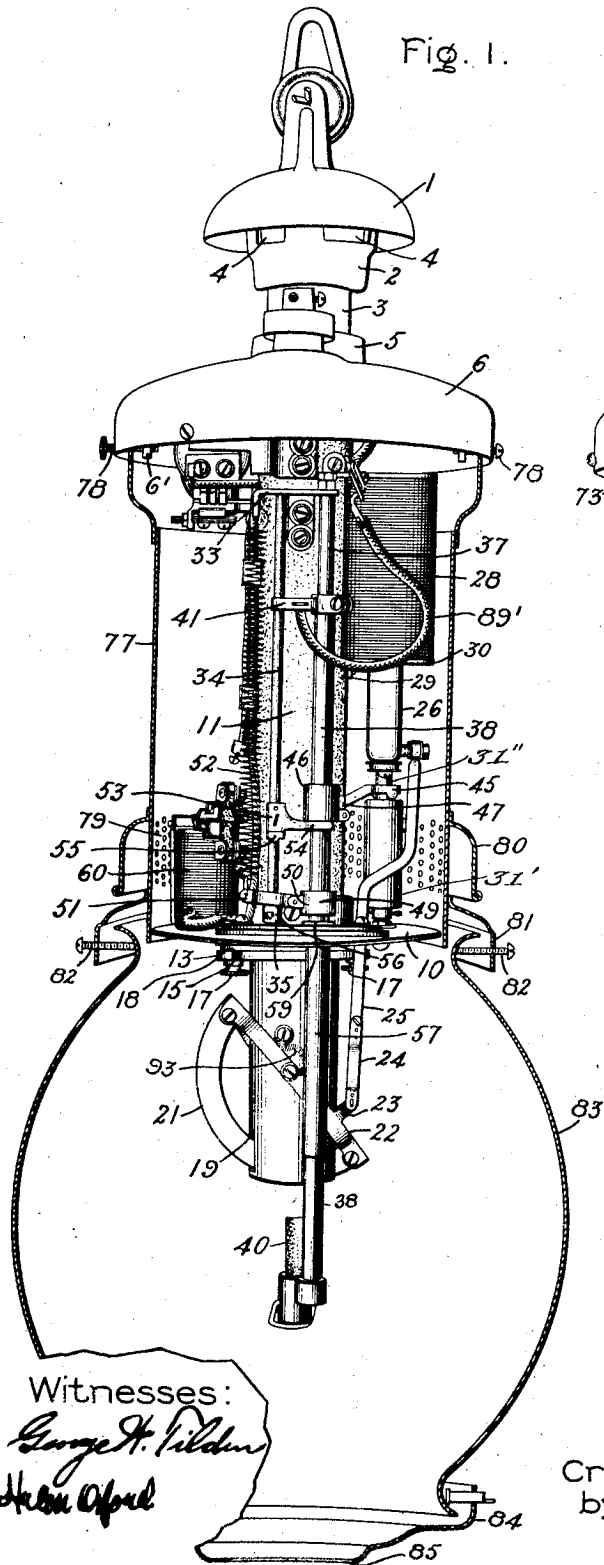
926,732.

Patented July 6, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

Fig. 2.



Witnesses:  
*George H. Tilden*  
*Harold O'Neil*

Inventors:  
Richard Fleming.  
Cromwell A. B. Halvorson, Jr.  
by *Albert S. Davis*  
Att'y.

R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED NOV. 16, 1903.

926,732.

Patented July 6, 1909.

2 SHEETS—SHEET 2.

Fig. 3.

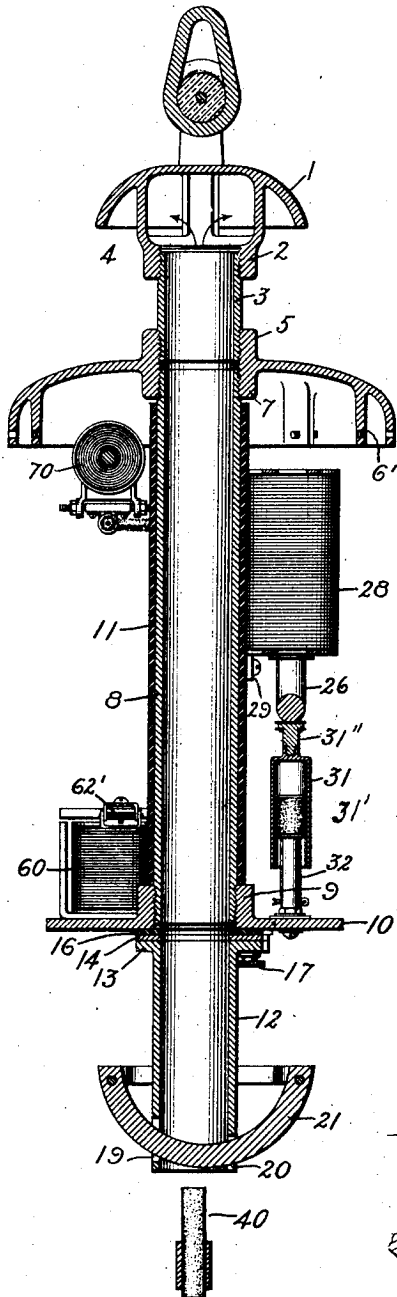


Fig. 4.

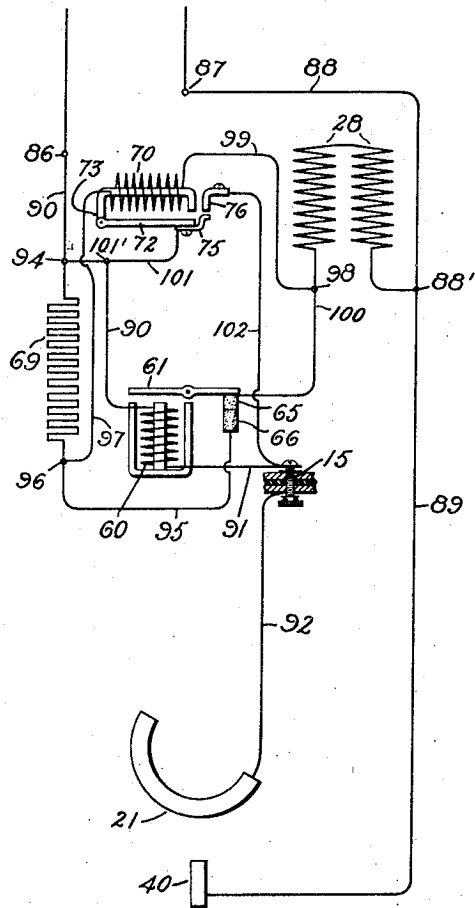


Fig. 5.

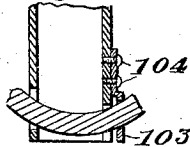
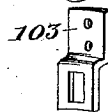


Fig. 6.



Witnesses:

*George H. Tilden.*  
*Helen Arford*

Inventors:

Richard Fleming.  
Cromwell A. B. Halvorson, Jr.  
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Att'y.

# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 926,732.

Specification of Letters Patent.

Patented July 6, 1909.

Application filed November 16, 1903. Serial No. 181,332.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING, and CROMWELL A. B. HALVORSON, JR., citizens of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

The object of our present invention is the improvement of arc lamps.

More particularly our invention relates to arc lamps in which the major portion of the illumination from the lamp is given by a flaming or luminous arc, as distinguished from those in which practically all of the illumination comes from electrodes heated to incandescence. With these lamps the products of combustion from the arc are not all permanent gases, as is substantially the case where carbon electrodes are employed, but contain matter which condenses to solid form upon contact with suitable condensing surfaces. This necessitates a lamp arranged so that the solid matter cannot be deposited where it will clog up or otherwise hurt the operation of the lamp. As the incandescence of the electrodes is not relied upon to furnish the major portion of the illumination of the lamp, it is often found desirable to form one of the electrodes out of good conducting material so proportioned and arranged that it will not be consumed by the heat of the arc, and our invention also comprises a novel construction and arrangement of this electrode.

The many novel features which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of our invention reference may be had to the accompanying drawings in which we have illustrated an embodiment of our invention.

Of the drawings, Figure 1 is a perspective view of an arc lamp with the casing and globe in section to disclose the mechanism of the lamp; Fig. 2 is another perspective view of the lamp viewed from a different position with the case and globe removed; Fig. 3 is a sectional elevation showing the lamp mechanism; Fig. 4 is a diagram illustrating the circuits of the lamp; and Fig. 5 is a partial sectional elevation and Fig. 6 is a perspective view illustrating an auxiliary electrode scraping mechanism.

Referring to the drawing, 1 represents a lamp cap or top on the upper side of which suitable means are provided by which the lamp may be suspended. From the under side of the cap or top 1 an integrally formed tubular boss 2 depends. This boss is threaded interiorly to receive the threaded upper end of a short metal tube 3, as is clearly shown in Figs. 1, 2 and 3 of the drawings. The boss 2 has a series of apertures 4 formed in it. The lower end of the tube 3 is also threaded to engage the upper end of the interiorly threaded cylinder 5 extending through and integrally connected to a circular member 6. The upper end of a section of metal tube 8 is threaded into the lower end of the cylinder 5. The section 8, which is similar to section 3, except that it is considerably longer, is also threaded at its lower ends to engage an interiorly threaded tubular boss 9, projecting upward from the disk-shaped platform 10. The section 8 is surrounded by a layer 11 of material which is an insulator both of heat and electricity.

A tube section 12 of metal is secured to the under side of platform 10, and extends in line and in open communication with the sections 3 and 8. In the construction which we have shown in the drawings, the upper end of the section 12 is provided with a flange 13, which abuts against a metallic washer 14, secured to the platform 10 by a pair of screws 15. The screws 15 are insulated from the platform 10 in any suitable manner, and a layer 16 of the insulating material is interposed between the washer 14 and the under side of the platform 10. Clamping nuts 17 on the ends of the screws 15 are employed for holding the flange 13 against the washer 14 and to the platform 10. Preferably open ended slots 18 are formed in the flange 13 through which the screws pass. This facilitates a ready removal of the tube 12 from the platform 10 whenever it becomes desirable. With the construction employed, it will be seen that the section 12 is secured to the platform 10 while it is at the same time insulated therefrom. Slots or grooves 19 and 20 are formed at opposite ends of the lower end of the section 12. A somewhat massive arc-shaped piece 21 of thermally and electrically conducting material, such as copper, having a considerable heat-dissipating capacity, passes through these slots and forms the non-con-

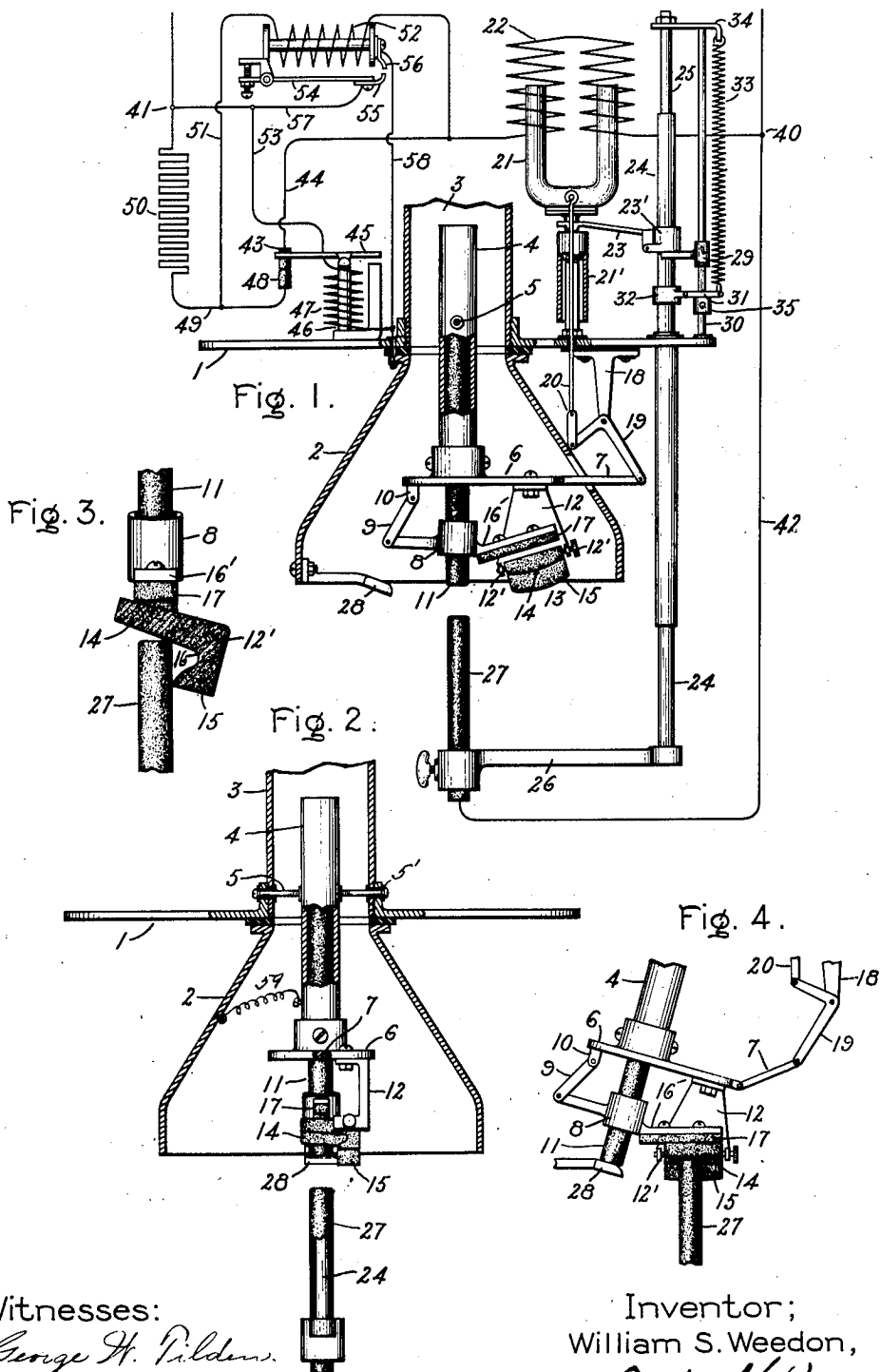
W. S. WEEDON.

ARC LAMP.

APPLICATION FILED JUNE 16 1904. RENEWED APR. 7, 1906.

926,793.

Patented July 6, 1909.



Witnesses:  
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*Spencer Oxford*

Inventor;  
William S. Weedon,  
by *Albin H. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

WILLIAM S. WEEDON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 926,793.

Specification of Letters Patent.

Patented July 6, 1909.

Application filed June 13, 1904, Serial No. 212,231. Renewed April 7, 1906. Serial No. 310,476.

To all whom it may concern:

Be it known that I, WILLIAM S. WEEDON, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention relates to arc lamps and more particularly to the mechanism and arrangement of parts of the lamp whereby an arc is "drawn" and the position of the electrodes is altered from time to time to compensate for the portions consumed by the arc.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be had to the accompanying drawings in which I have shown somewhat diagrammatically one embodiment of my invention.

Of the drawings, Figure 1 is an elevation partly in diagram and with parts broken away and in section, of a portion of an arc lamp equipped with my invention; Fig. 2 is a sectional elevation taken at right angles to Fig. 1 and showing a part only of the mechanism shown by Fig. 1; Fig. 3 is a view taken similarly to Fig. 1 showing a portion only of the mechanism shown in Fig. 1 and a different condition of the lamp; and Fig. 4 is a view taken at right angles to Fig. 3 showing a portion of the mechanism in Fig. 4 in the condition of the lamp shown in Fig. 3.

My invention may be advantageously employed in connection with a lamp of the general character shown and described in an application for patent on arc lamps, filed jointly by Richard Fleming and Cromwell A. B. Halvorson, Jr., on the 16th day of November, 1903, the serial number of which is 181,332, though my invention in all of its features is not limited to use in connection with any particular form of lamp.

The mechanism shown in Fig. 1 is substantially the same as that shown in the application above noted except as it is modified by the employment of my present invention.

Referring to the drawings, 1 represents a platform forming a part of the frame work of

the lamp. A conical member 2 forming a part of the draft tube or chimney of the lamp has its upper and smaller end secured to but insulated from the under side of the platform 1 in any suitable manner. A tubular chimney member 3 in line and in open communication with the conical member 2 extends upward from the platform 1.

A tubular electrode holder 4 is pivotally connected to the tubular member 3 by trunnions 5 turning in bushing 5 of insulating material. The lower end of the holder 4 carries a platform 6. An arm 7 pivoted to the platform 6 extends through an aperture formed for the purpose in the member 2. A washer clutch 8 has a link member 9 pivoted to its side. The other end of the link member 9 is pivoted to a bracket 10 depending from the under side of the platform 6. The lower end of the upper electrode 11 of the lamp projects out of the holder 4 through the yoke of the clutch 8, being normally held locked to the holder 4 by the clutch 8, as shown in Fig. 1. The electrode 11 may be formed of any suitable material, as carbon.

An extension 12 secured to the platform 6 has pivotally secured to it a shaft 12' which supports a block 13 of suitable conducting material, such as carbon. The block 13, which forms an auxiliary electrode of the lamp, appears substantially L-shaped when viewed end on, as in Fig. 4. The under surface of the upper portion or leg 14 of the block 13 is substantially cylindrical about the pivotal axis of the holder 4. The portion or leg 15 of the block 13 is under-cut at 16 as shown in Fig. 3. An extension 16' of the clutch member 8 extends over the portion 14 of the block 13. A block 17 of carbon may be secured to the under side of the extension 16', as shown. When the block 13 is oscillated about its axis in a manner hereinafter described the upper side of portion 14 engages the block 17 and moves the clutch member 8 to cause it to release the electrode 11.

A bracket 18 secured to but insulated from the under side of the platform 1 supports a pivotally-mounted bell-crank lever 19. One arm of the bell-crank lever is pivotally connected to the arm 7. The other and shorter arm of the bell-crank lever is connected by links or bars 20 to a U-shaped armature 21 which, with its cooperating

winding 22, is mounted above the platform 1. The connection between the upper link 20 and armature 21 is such that the link and armature are insulated from each other. To the under side of the armature 21 is secured one end of a pawl 23 of a clutch 23', the yoke of which surrounds a vertical tubular member 24. A dash-pot 21' is employed to retard the downward movement of the armature 21. The member 24 which slides upon a suitably-supported guide rod 25 carries at its lower end an arm 26 at the outer end of which is formed a socket in which the lower electrode 27 of the lamp is held in line with the axis of the members 2 and 3. The electrode 27 is preferably formed out of or contains some substance giving a flaming or luminous arc, such as titanium carbide. When the electrode is formed of or contains titanium carbide it should preferably be coated with metal such as copper. When the winding 22 is energized in a manner hereinafter described, the armature 21 will be raised and the clutch 23' will engage the member 24 and raise the electrode 27. At the same time the bell-crank lever 19 will be oscillated and the holder 4 will be swung about its pivotal axis until the block 13 is moved into line with the electrode 27. When the electrode 27 engages the portion 14 of the block 13 the block will be turned about its pivotal axis and the portion 15 of the block 13 will engage the electrode 27 some distance below its arcing end. As the block 13 turns about its axis the portion 14 will engage the block 17 and cause the clutch 8 to release the electrode 11 which will thereupon drop into engagement with a stop 28 carried for the purpose by the member 2.

When the clutch 23' is in the position shown in Fig. 1 its yoke rests upon the upper surface of stop 29 adjustably mounted on a rod 30 extending upward from the platform 1. Under these circumstances the member 24 is free to move through the clutch 23'. The pawl 31 of a clutch 32 is normally held in engagement with the member 24 by the action of the spring 33, the lower end of which is secured to the outer end of the pawl 31 and the upper end of which is secured to a cross-bar 34 which connects the rods 25 and 30.

When the member 24 is raised as heretofore described, the clutch 32 will move upward with it until the pawl 31 strikes the lower surface of the stop 29 after which the member 24 will move through the yoke of the clutch 32. In the position shown in Fig. 1 the pawl 31 rests against the upper side of a stop 35 also adjustably secured to the rod 29. In this position of the pawl 31 the member 24 is held between the pawl and the yoke of the clutch 32 and is thereby prevented from moving downward.

The circuit arrangements of the lamp and

its operation may be understood by reference to Fig. 1, in which 40 and 41 represent the lamp terminals. A conductor 42 connects the terminal 40 to the electrode 27. One terminal of the winding 22 is also connected to the terminal 40. The other terminal of the winding 22 is connected to a contact member 43 by a conductor 44. The contact member 43 is carried by an armature 45 pivotally mounted on the core 46 of the electromagnet 47. When the electromagnet 47 is deenergized the contact 43 is in engagement with the contact member 48, and when the electromagnet is energized the contacts 43 and 48 are separated. The contact member 48 is connected by a conductor 49 to one terminal of a resistance conductor 50, the other end of which is connected to the terminal 41. A conductor 51 connects one terminal of voltage coil 52 with the line 49, the other terminal of the voltage coil 52 being connected to the conductor 44. A conductor 53 connects the lamp terminal 41 with one end of the winding of the electromagnet 47. The other end of the winding of the electromagnet 47 is in electrical connection with the member 2 and thereby with the holder 4, electrode 11 and block 13. A pivoted armature 54 cooperating with the core of the voltage coil 52 carries a contact 55 which is normally separated from but is adapted, under some circumstances, to engage a contact 56 carried by the core of the magnet. A conductor 57 connects the contact 55 to the conductor 53. A conductor 58 connects the contact 56 to the lower terminal of the winding of the electromagnet 47. The members 2 and 4 are electrically connected together by a flexible conductor 59.

The out-of-service as well as the normal running condition of the lamp is shown in Fig. 1. When the lamp terminals are connected to a suitable source current will begin to flow between the terminals 40 and 41, through the winding 22, conductor 44, contacts 43 and 48, conductor 49 and resistance conductor 50. The passage of current through the winding 22 will cause the armature 21 to be raised. This will move the electrode 27 into contact with the under side of the portion 14 of the block 13 which will then be oscillated into the position shown in Fig. 3.

The parts are usually so constructed that the electrode 27 will clear the portion 15 of the block 13 as it moves upward. When the upper end of the electrode 27 engages the under side of the portion 14 of the block 13 the block 13 will be tilted and the lower end of the portion 15 will be forced against the side of the electrode 27 at a point far enough below its upper end to insure freedom from the presence of non-conducting material which may be formed at the tip of the electrode by the arc. At the same time the elec-

trode 11 will be oscillated into line with the stop 28. As soon as the tilting of the block 13 causes the clutch 8 to release the electrode 11 the electrode will drop into engagement with the stop 28.

Immediately upon the engagement of the electrode 27 and block 13 current will begin to flow between the block and the electrode through a circuit which includes the conductor 42, electrode 27, block 13, winding of the electromagnet 47 and conductor 53. Passage of current through the winding of the electromagnet 47 will cause the armature 45 to be oscillated and thereby separate the contacts 43 and 48. When this occurs the winding 22 will no longer be operatively energized and the electrode 27 will begin to descend and the holder 4 and parts carried thereby will start back to the position shown in Fig. 1.

As the block 13 and the electrode 27 separate an arc will usually be drawn between the portion 15 and the side of the electrode which will first be transferred from the portion 15 to the portion 14 of the block 13 and thence to electrode 11 as the movement of separation continues. The heat produced by the arc will soon cause the end of the electrode 27 to become conducting, after which the arc will extend from the end of the electrode. In some cases sufficiently good contact may be established between the ends of the electrode 27 and the portion 14 to cause the arc to be formed initially between them. The downward movement of the electrode 27 and thereby the arc length will be limited by the engagement of the pawl 31 with the stop 35.

As the electrode 27 starts downward the block 13 will turn about its own axis and the clutch will engage the electrode 11 as its end moves off the stop 28. As clearly shown in Fig. 1 in the normal position of the parts the distance between the end of the electrodes 11 and 27 is considerably less than the distance between the ends of the electrode 27 and the block 13, and in the feeding operation of the lamp the upper end of the arc readily jumps from the block 13 to the electrode 11. The transfer of the arc is facilitated apparently by the upward draft tending to hold the arc vertical produced by the heat of the arc. The transfer of the arc is also facilitated by the use of the block 17 of carbon.

The voltage coil 52 is so proportioned that with the ordinary arc length the current passing through its windings will be insufficient to cause the armature 54 to be attracted. When, however, the voltage of the arc increases to a predetermined maximum the current passing through the winding 52 will cause the armature 54 to be attracted and thereby bring the contact 56 into engagement with the contact 55. This throws a low resistance shunt, which comprises the

conductor 57, contacts 55 and 56 and conductor 58, about the winding of the electromagnet 47 whereupon the electromagnet will be deenergized and the contact member 43 will move into engagement with the member 48 and close the circuit through the winding 22. The electrode 27 will then again be moved into engagement with the under side of the portion 14 of the block 13 after which the arc will again be struck in a manner hereinbefore described. The feeding operation will be repeated whenever the voltage of the arc rises above a predetermined maximum.

It will be readily understood that when each feeding action takes place the clutch 32 will move with the tubular member 24 until the pawl 31 strikes the under side of the stop 29 after which the member 24 will be moved through the yoke of the pawl 32 an amount equal to the length of the electrode 27 consumed since the previous feeding operation. Since at each feeding operation of the lamp the electrode 11 moves downward in its holder until its lower end engages the stop 28, the length of the arc struck after each feeding operation is fixed and the arc itself extends between the same pair of horizontal planes after each feeding operation.

With the construction employed it will be observed that the lower edge of the block 13 is positively forced against the side of the electrode 27 with a pressure proportionate to the lifting action of the winding 22 of the armature 21. This can be adjusted to obtain any desired amount of pressure. As the block 13 can be made quite massive and as the arc extends from it only for a short time during each interval, its consumption will be very slow. With the construction employed, however, renewal of the block can take place whenever necessary. As the under surface of the portion 14 of the block 13 is substantially cylindrical about the pivotal axis of the holder 4 there is no tendency to a wedging or locking action between the electrode 27 and the block 13 when they move together. This arrangement of the under surface 14 also insures an arc length after each feeding operation of constant length regardless of the consumption of the lower electrode since the preceding feeding operation.

When the negative electrode of the lamp is formed of material like titanium carbide there is a tendency to a deposit of slagging material on the lower end of the upper electrode transferred from the lower electrode by the arc. To avoid any injurious consequence from this tendency the electrode should be so proportioned that the upper electrode will be consumed rapidly enough to prevent the accumulation of the slagging material upon its arcing end. When the electrodes are of substantially equal diameter and the lower electrode is formed of titanium carbide and the upper electrode is formed of carbon this re-



sult is obtained. The use of electrodes of the character specified gives a steady and efficient flaming or luminous arc.

The particular lamp which I have herein-  
5 before illustrated and described in detail is intended for operation in a direct constant current system, the lower electrode being the negative. It is obvious, however, to all those skilled in the art that my invention may be  
10 employed in a lamp for use on a constant potential circuit or that it may be employed in an alternating-current system.

What I claim as new and desire to secure by Letters Patent of the United States, is,

15 1. In an arc lamp, a pair of cooperating electrodes normally in line with each other, and means for oscillating one of said electrodes out of line with the other and for moving the other electrode toward the first electrode in a feeding operation of the lamp.

20 2. In an arc lamp, the combination of an electrode restricted to movement in the line of its axis, a second electrode normally in axial alinement with the first, a stop out of  
25 alinement with the electrodes, and means for moving the second electrode into line with the stop.

30 3. In an arc lamp, two electrodes normally in axial alinement, a stop out of alinement with the electrodes, means for moving one of the electrodes into line with the stop, and means for releasing said electrode to move into contact with the stop.

35 4. In an arc lamp, two electrodes normally in axial alinement, a stop normally out of alinement with the electrodes, and means for moving one of said electrodes into line with said stop and means for thereafter allowing it to drop into engagement with the same in a  
40 feeding operation of the lamp.

5. In an arc lamp, an electrode holder, a main electrode normally held in fixed relation therewith by a clutch mechanism, a movable auxiliary electrode in cooperative  
45 relation with said clutch mechanism, a stop, a second main electrode, and means for moving the second main electrode into engagement with the auxiliary electrode to move the latter and thereby cause the clutch mechanism to release the first-mentioned main  
50 electrode and allow it to move into engagement with said stop.

55 6. In an arc lamp, a draft tube, an electrode holder pivotally mounted therein, an electrode carried by said holder, and normally held in line with the axis of said tube,

a stop out of line with the axis of said tube, a clutch carried by the holder normally engaging said electrode, a movable auxiliary electrode carried by the holder in such manner  
60 that its movement will cause the clutch to release the first-mentioned electrode, a third electrode, and means for oscillating said holder to move the first-mentioned electrode into line with the stop and for bringing about  
65 an engagement between the third electrode and the auxiliary electrode which will cause a movement of the auxiliary electrode to release the first-mentioned electrode and allow it to drop into engagement with said stop. 70

7. In an arc lamp, a holder, a stop, a main electrode normally locked to the holder and held out of line with the stop, an auxiliary electrode carried by the holder, a second  
75 main electrode, means for moving the second main electrode into engagement with the auxiliary electrode and for moving the first-mentioned electrode into line with the stop, and means actuated by the engagement between the second main electrode and the  
80 auxiliary electrode for releasing the first-mentioned main electrode from the holder whereby the first-mentioned electrode may drop into engagement with the stop.

8. In an arc lamp, a main electrode, a  
85 second main electrode normally in line with the first-mentioned electrode, a cooperating electrode normally out of line with the first-mentioned electrode, means for moving each main electrode in the direction of its length  
90 to compensate for its consumption, and means for moving the second main electrode out of line and the cooperating electrode into line with the first-mentioned electrode in a feeding operation of the lamp. 95

9. In an arc lamp, an electrode, mechanism normally preventing a movement of the electrode in the direction of its length, a stop out of the normal line of the axis of said  
100 electrode, intermittently actuated means for changing the relative positions of the electrode and stop to bring them into alinement, and means for thereafter actuating said mechanism to permit said electrode to move in the direction of its length into engagement  
105 with said stop.

In witness whereof, I have hereunto set my hand this 28th day of May, 1904.

WILLIAM S. WEEDON.

Witnesses:

G. C. HOLLISTER,  
HELEN ORFORD.

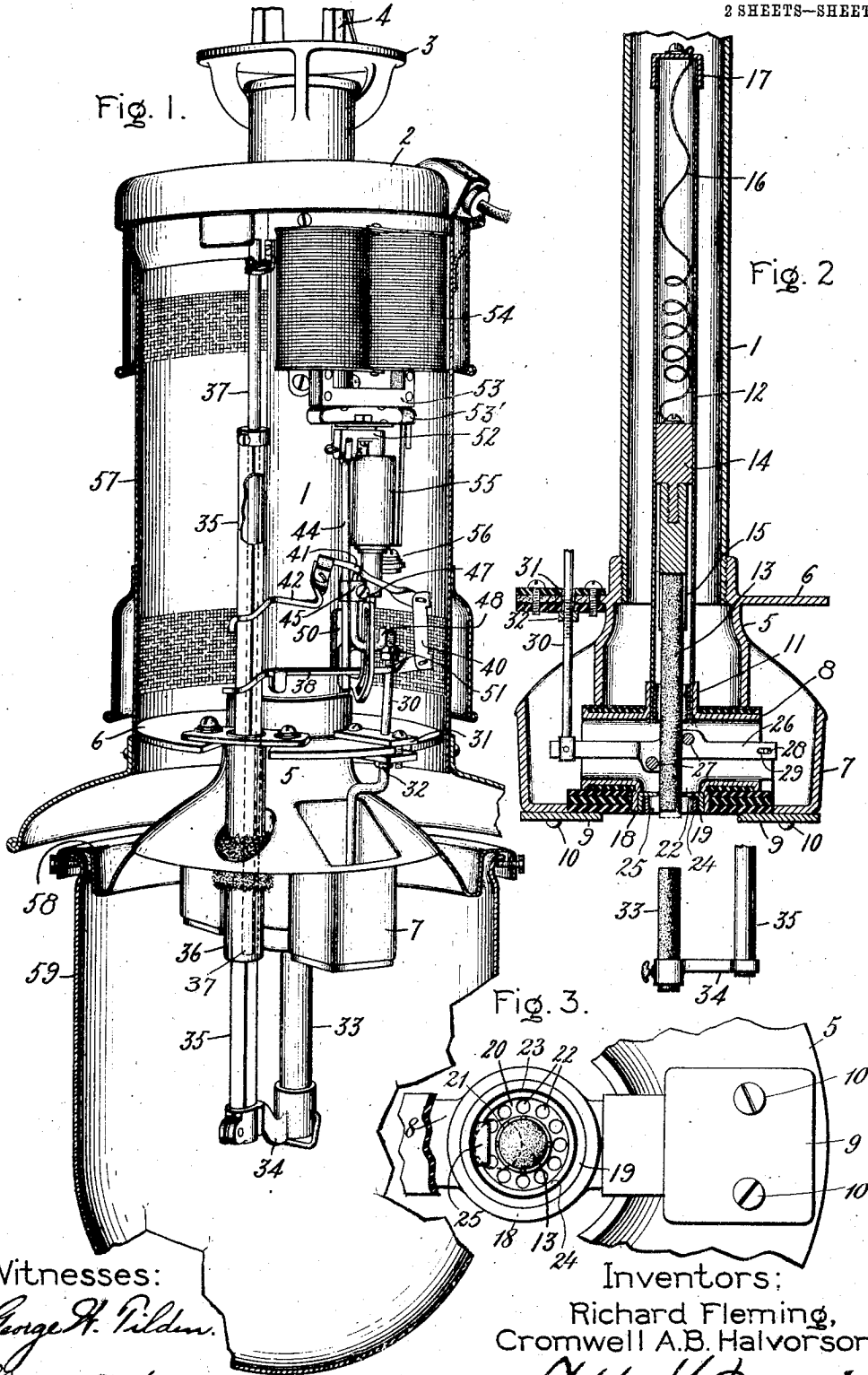
R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED JAN. 16, 1906.

928,189.

Patented July 13, 1909.

2 SHEETS—SHEET 1.



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Inventors:  
Richard Fleming,  
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R. FLEMING & C. A. B. HALVORSON, JR.

ARC LAMP.

APPLICATION FILED JAN. 16, 1906.

928,189.

Patented July 13, 1909.

2 SHEETS—SHEET 2.

Fig. 5.

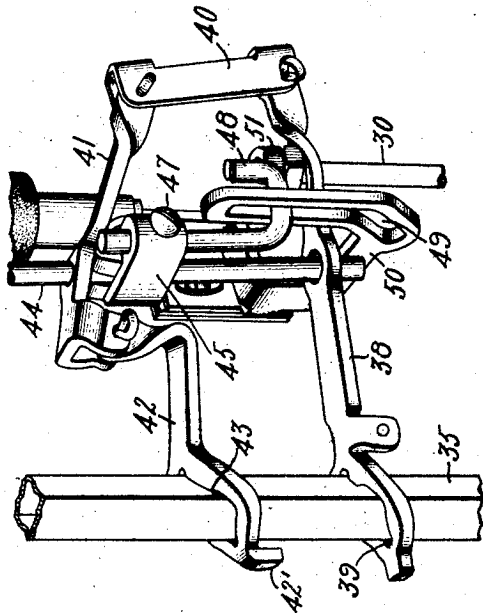
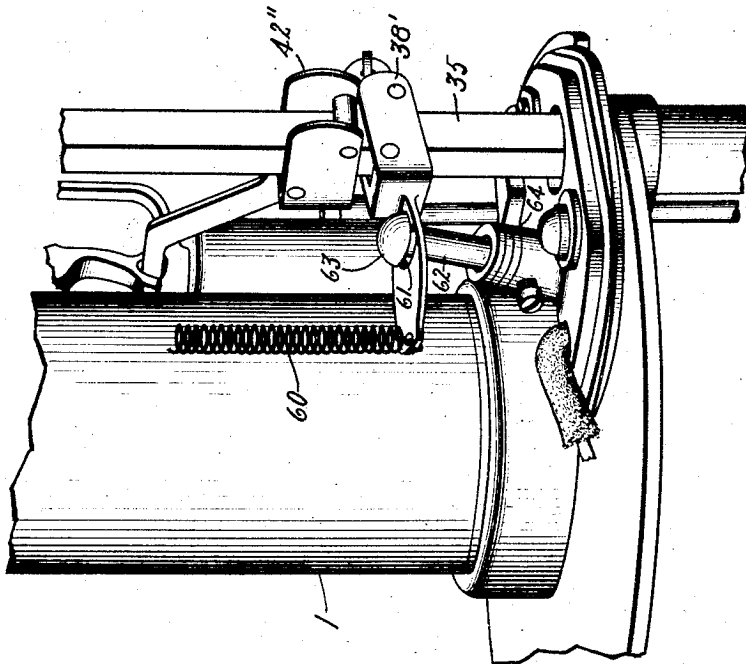


Fig. 4.



Witnesses:

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Inventors:

Richard Fleming,  
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by *Albert H. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

No. 928,189.

Specification of Letters Patent.

Patented July 13, 1909.

Application filed January 16, 1906. Serial No. 296,303.

To all whom it may concern:

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, JR., citizens of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

Our present invention relates to arc lamps and comprises certain improvements in the electrode feeding mechanism of such lamps. These improvements are intended to produce an arc of constant length and in fixed relation to the arc lamp structure at each feeding operation in the particular embodiment of our invention disclosed.

Our invention also comprises features of construction and arrangement particularly adapted for use in arc lamps of the luminous or flaming arc type in which the electrodes employed are such that a relatively long arc is obtained and the arc products contain fumes which require special provision for their disposal.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of our invention and for the advantages possessed by it reference may be had to the accompanying drawings and descriptive matter in which we have illustrated and described some of the forms in which our invention may be embodied.

Of the drawings, Figure 1 is a perspective view of an arc lamp with casing and globe broken away and in section; Fig. 2 is a sectional elevation illustrating the lamp ventilation and the arrangement of the upper electrode; Fig. 3 is an inverted plan showing the lower end of the lower electrode and nozzle surrounding mechanism; Fig. 4 is a perspective view of a portion of an arc lamp illustrating a modified electrode feeding mechanism; and Fig. 5 is a perspective view illustrating the clutch mechanism used in the lamp shown in Fig. 1.

In the construction disclosed in Figs. 1 and 2 an arc lamp is shown in which the backbone of the arc lamp frame-work is formed by a draft tube or chimney member 1. To the member 1 at a short distance below its upper end is secured a hood 2. To the ex-

treme upper end of the chimney member 1 or an extension thereof, is secured a carrier member 3 from the upper side of which may extend members 4 through which the lamp is suspended. In the construction shown, the lower end of the chimney member 1 is in threaded engagement with a bell-shaped fume box or hood member 5. The member 5 is provided with an annular flange portion 6 which forms the lower platform of the arc lamp. From the conical portion of the member 5 below the platform 6 extend two box-like chambered portions or pockets 7 open at their upper ends diametrically opposed to each other with respect to the axis of the member 5.

Openings are formed in the adjacent inner walls of the member 7 into which project the ends of a hollow member 8. As shown, the member 8 is separated from the portion 7 by insulation and is held in place by means of plates 9 secured to the lower ends of the portion 7 by screws 10. The member 8 is formed with a tubular boss 11 projecting from its upper side and coaxial with the chimney member 1. The lower end of a tube-like member 12 is secured in the boss 11. The lower end of the upper electrode 13 of the lamp projects from the lower end of the member 12 which serves as a shield or receptacle for the electrode. The upper end of the electrode 14 is secured to a suitable follower, the lower end of which may be provided with the usual spring clips 15 for engaging the electrode. A flexible conductor 16 connects the follower 14 to the cap member 17 which closes the upper end of the member 11. A tubular boss 18 extends downward from the under side of the member 8. A cap-like member comprising a cylindrical portion 19, to the upper end of which is connected a horizontal portion or diaphragm 20, is suitably secured in the boss 18. A central aperture 21 is formed in the portion 20 through which the lower end of the electrode 13 projects. A series of apertures 22 are also formed in the portion 20 surrounding the aperture 21. Within the cap-like member and preferably separated from it by insulation 23 is secured an annular member 24 which is provided with an inwardly extending projection 25 forming a stop for limiting the upward movement of the lower electrode in a manner hereinafter described.

A clutch member for the upper electrode comprising a lever or bar 26 provided with projections 27 between which the electrode 13 passes, is connected to the member 8 by means of a pin 28 secured to the latter which passes through a slot 29 formed in one end of the member 26. The other end of the member 26 is connected to a partially threaded operating rod 30 which projects up through the upper open end of one of the pockets 7 and through an insulating guide 31 secured for the purpose in an opening in the platform 6. When the member 30 does not hold up the end of the member 26 to which it is connected the electrode is gripped between the projections 27. When, however, an upward pull is exerted upon the member 30 the lever 26 is tilted so that the upper electrode is released and is free to move downward under the action of gravity. Nut 32 threaded on the rod 30 engages the under side of the guide 31 to limit the upward movement of the member 30.

The lower electrode 33 which in the working position of the lamp shown in Fig. 2 is in axial alinement with the electrode 13, is supported in a socket formed in a bracket arm 34 carried at the lower end of a hollow bar-like member 35 which is rectangular in cross-sectional outline. The member 35 slides through a tubular member 36 secured to the platform 6 extending down through an opening formed for the purpose in the conical portion of the member 5, and slides upon a member 37 secured to the framework of the lamp in any suitable manner. The member 35 is engaged by two clutches located between the platform 6 and the hood 2. The lower clutch in the form shown in Figs. 1 and 5 of the drawings comprises a bar-like member 38 provided with an aperture 39 at one end through which the member 35 extends. The member 38 is so arranged that when its end opposite to that containing the aperture 39 is raised, the member 35 is cramped in the opening 39 to lock the members 35 and 38 together. The end of the member 38 remote from the member 35 is pivoted to the lower end of a link-like member 40. The upper end of the member 40 is pivotally connected to a link-like member 41 to the other end of which is pivotally connected a member 42 provided with an aperture 43 through which the member 35 passes. The member 41 is formed with an aperture between its ends and adjacent the member 42 through which loosely passes a rod 44. The rod 44 has secured to it a fulcrum member 45 which engages the under side of the member 41. When the rod 44 is pulled upward and the adjacent end of the member 42 correspondingly raised the member 35 is cramped in the opening 43, thus locking the members 35 and 42 together.

The member 44 is extended to pass through

an opening formed for the purpose in the member 38. Adjustably secured to the member 45 by means of screws 47 is a hook shaped member 48. The hook portion of the member 48 extends through a slot 49 in a slotted member 50 secured to the chimney member 1. As shown, the slot 49 comprises an upper vertical portion and a lower inclined portion. The member 38 is provided with an aperture through which the upper end of the clutch operating member 30 extends. A pair of nuts 51 secured to the upper end of the member 30 serve as a means by which the amount of upward movement of the member 38 necessary to cause the member 30 to be elevated to release the upper electrode can be adjusted. The upper end of the rod-like member 44 is pivotally connected to a member 52 connected to the under side of the U-shaped armature 53 by springs 53'. The legs of the armature 53 extend into solenoid coils 54. The movable shell member 55 of a dash-pot is secured to the member 52. The stationary piston member 56 of the dash-pot is secured to an extension of the member 50.

When the lamp is in the out-of-service position the electrodes are in the position shown in Fig. 2, the lower electrode being supported by the member 38 which in turn is supported by the plate 50. In this condition of the lamp the upper electrode is gripped between the pins 27. As soon as the lamp is connected into the operating circuit the coils 54 are energized. This causes the armature 53 to be attracted, thus elevating the member 44. The initial upward movement of the member 44 causes both clutch members 38 and 42 to grip the member 35, after which the member 35 and the entire clutch mechanism moves upward with the member 44 until the upward movement of the member 38 is checked by the member 30. After the upward movement of the member 38 is checked by the member 30 through the nuts 32 and 51 further upward movement of the member 44 causes the member 42 to tilt about the fulcrum block 45 causing a further upward movement of the member 35 which is then moved through the aperture 39. As the member 45 moves upward the hook portion of the member 48 moves out of the lower end of the inclined portion of the slot 49 into the vertical portion of the slot. This movement causes a lateral movement of the member 45 and thereby of the lower end of the member 44 which through the clutch mechanism turns the member 35 about the rod 37 as an axis. This results in throwing the lower electrode from a position in alinement with the upper electrode to the position indicated by the dotted line in Fig. 3. The upward movement of the member 35 is checked by the engagement of the upper end of the electrode 38 with the projection 25.

A. D. JONES.  
ELECTRIC ARC LAMP.  
APPLICATION FILED SEPT. 16, 1907.

935,518.

Patented Sept. 28, 1909.

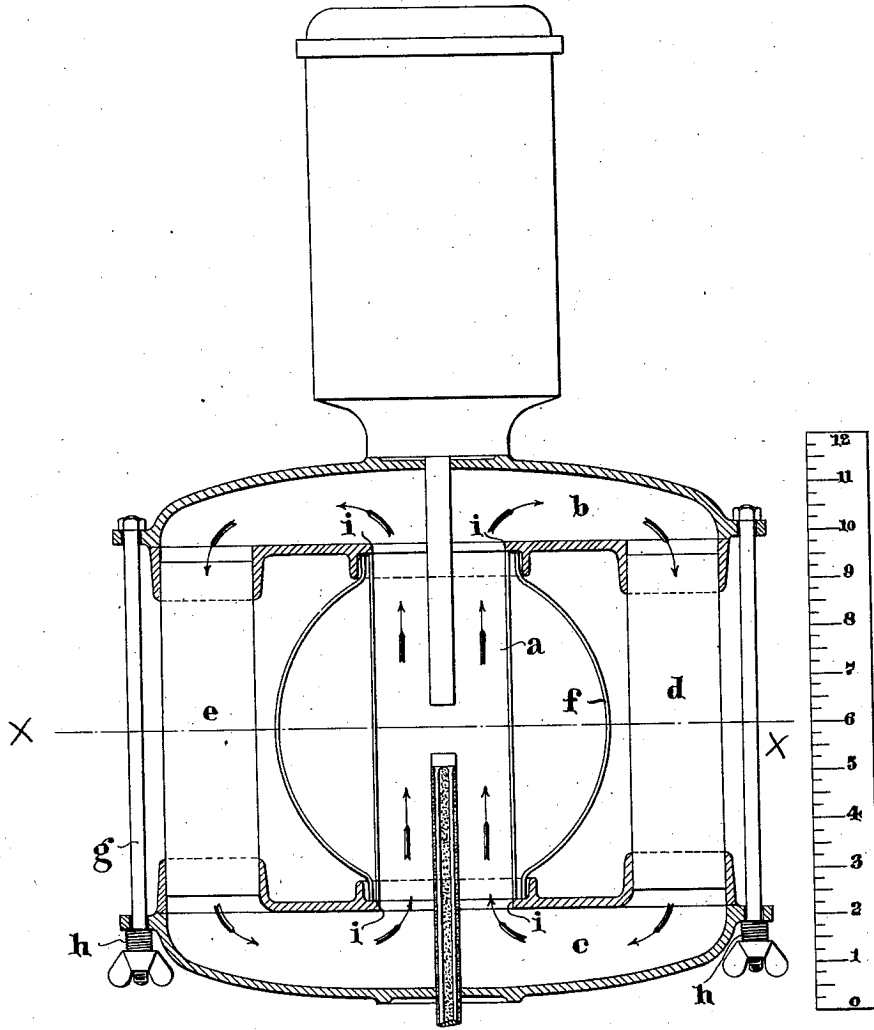


Fig. 1.

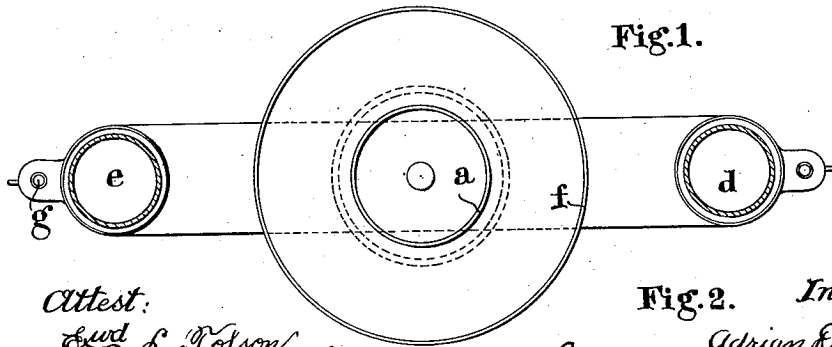


Fig. 2. Inventor,

Attest:  
Edw. L. Tolson.  
Edward N. Sinton

Adrian D. Jones  
By Spear, Waddell, Donaldson & Spear,  
Attys.

# UNITED STATES PATENT OFFICE.

ADRIAN DENMAN JONES, OF HOLLOWAY, LONDON, ENGLAND.

## ELECTRIC-ARC LAMP.

935,518.

Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed September 16, 1907. Serial No. 393,145.

To all whom it may concern:

Be it known that I, ADRIAN DENMAN JONES, a subject of the King of Great Britain and Ireland, and residing at 39 Hartham road, Holloway, in the county of London, England, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

My invention relates to electric arc lamps of the inclosed type in which the arc is burned in an inclosure substantially airtight.

The object of the invention is to construct an inclosed arc lamp having compound carbons containing chemicals adapted to increase the power and steadiness of the light, the form of the inclosure being such that the chemical vapors are maintained for a long time in the flame, while efficient circulation of the gases is provided for, so that the walls of the chamber surrounding the arc are kept clear of deposit.

I have found that for successful working of inclosed arc lamps using carbons carrying chemicals, it is necessary that the chemicals added should give off vapors having a high vapor density and thus forming a comparatively small arc and therefore a small region within which the electrical energy is dissipated, the effect of this being to raise the vapors in the arc to a high degree of incandescence giving a high light efficiency. I have also found that it is desirable to add salts having a high melting point, and for this reason it is desirable to add a steadying salt which acts as a flux in melting the chemicals to form a uniform liquid before vaporization. I find that with such mixtures no liquid slags are formed, and therefore the troubles caused in other lamps in which chemicals are used are completely avoided.

My invention consists in an inclosed arc lamp in which the electrodes are disposed in a substantially air tight chamber of small capacity formed of a transparent or translucent arc inclosing part and one or more short passages connecting the ends of said part whereby the gases are circulated in such a manner as to substantially prevent the

formation of eddies and deposit on the arc-inclosing walls, the hot ascending gases sweeping the walls in a rapid current.

My invention further consists in an inclosed arc lamp having compound carbons containing a mixture of salts of high vapor density and high melting point with the addition of a steadying salt, the carbons being situated in an inclosure of small capacity having a passage or passages connecting its upper and lower ends in such a manner that a current of gases is caused to sweep through the chamber containing the arc.

My invention also consists in the improved flame arc inclosed lamp hereinafter described.

Referring to the accompanying drawings, Figure 1 shows a sectional elevation of a lamp constructed according to my invention; Fig. 2 is a horizontal section on the line X-X, Fig. 1.

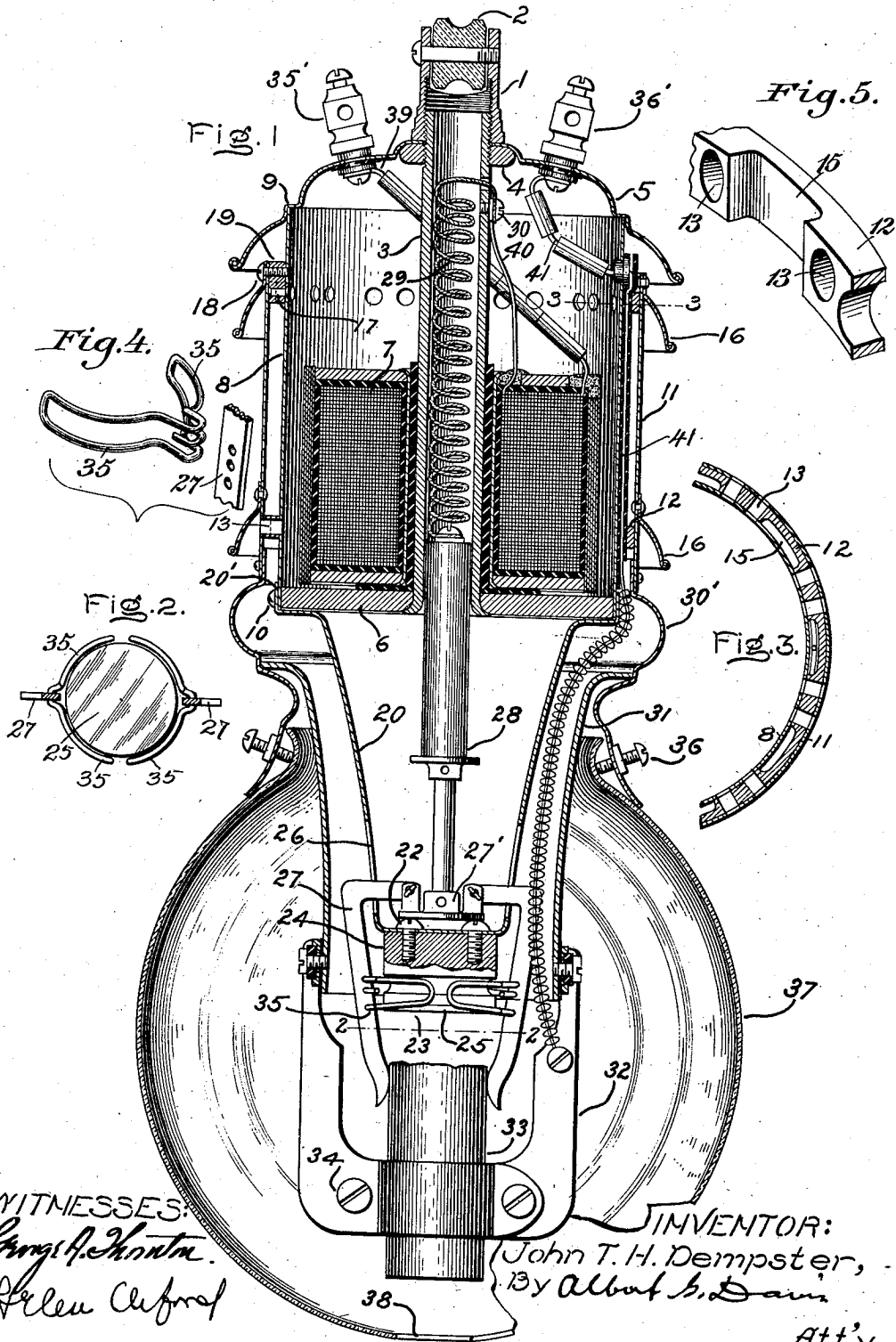
In carrying my invention into effect according to one form I provide a transparent or translucent chamber, *a*, in which the electrodes are disposed and which communicates at each end with chambers, *b* and *c*. Passages *d* and *e*, interconnect the chambers, *b* and *c*, so as to provide definite paths for the circulation of the gases and also to provide for condensation of the fumes arising from the combination of the chemicals with which the positive carbon of the electrodes is generally incorporated. A globe, *f*, of any suitable description surrounds the chamber, *a*. The lamp is constructed of three principal parts as shown the center one of which carries the chamber, *a*, and the passages, *d* and *e*, while the upper and lower parts form the top and bottom respectively of the chambers, *b* and *c*. The three parts are connected together by the rods, *g*, in such a manner that the parts can be assembled or taken apart as required with facility and expedition.

The transparent envelop seats against shoulders, *i*, and to maintain air tightness the top and bottom parts must be free to move with the expansion and contraction of the inclosure. To effect this conveniently the tubes forming the passages *d* and *e*, are sweated at one end and a sliding fit in their

J. T. H. DEMPSTER.  
 ARC LAMP.  
 APPLICATION FILED MAY 1, 1905.

935,896.

Patented Oct. 5, 1909.



WITNESSES:  
*George A. Schmitt*  
*Heleu Alfred*

INVENTOR:  
 John T. H. Dempster,  
 By *Albert S. Davis*  
 Att'y.



# UNITED STATES PATENT OFFICE.

JOHN T. H. DEMPSTER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

935,896.

Specification of Letters Patent.

Patented Oct. 5, 1909.

Application filed May 1, 1905. Serial No. 258,209.

To all whom it may concern:

Be it known that I, JOHN T. H. DEMPSTER, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention relates to arc lamps and more particularly to arc lamps in which the electrodes employed are so slowly consumed by the action of the arc that it is unnecessary to provide means for automatically feeding the electrodes in order to compensate for the electrode consumption.

My invention comprises certain features of construction and arrangement in arc lamps of more or less general utility but peculiarly adapted for use in arc lamps with non-feeding electrodes.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be had to the accompanying drawings and description in which I have illustrated and described one form in which my invention may be embodied.

Of the drawings, Figure 1 is a vertical axial section of an arc lamp showing some parts in elevation; Fig. 2 is a partial section on the line 2 2 of Fig. 1 looking up; Fig. 3 is a partial section on the line 3 3 of Fig. 1; Fig. 4 is a perspective view of one of the scrapers and of a portion of an auxiliary electrode but disconnected from the scraper, and Fig. 5 is a perspective view of a portion of the structure shown in Fig. 3.

Referring to the drawings, 1 represents the top member of the lamp proper provided with means such as a porcelain pulley or roller 2 by which the lamp may be supported. The member 1, which is tubular, is internally threaded to receive the upper end of the externally threaded tubular member 3 which forms the back-bone of the frame work of the lamp. A nut 4 threaded on the upper end of the member 3 below the top member 1 clamps a hood 5 in place. The hood 5, which may be formed of sheet metal, is symmetrical with respect to the member 3 and has a hole formed in it through which the member passes. The lower end of the member 3 supports a platform 6. In the

construction shown the platform 6 is apertured to receive the lower end of the member 3 which is flared out to engage and support the platform 6. A tubular magnetizing coil or winding 7 surrounds the member 3 and rests on the platform 6. It will of course be understood that the winding 7 is suitably insulated from the member 3 and the platform 6.

The inner wall of a double walled casing extends from the platform 6 to the hood 5. As shown, the inner wall 8, which is cylindrical, fits tightly against the under surface of the hood 5 which may have a shoulder 9 formed as shown against which the upper end of the casing 8 abuts. The lower end of the casing 8 closely embraces the periphery of the platform 6 to which it is secured by screws 10. The outer wall 11 of the casing which is concentric with the inner wall is separated therefrom by two annular spacing members 12 placed one near the upper end of the wall 11 and one near the lower end of the wall 11. The members 12 are formed with radially extending passages 13 which register with apertures formed for the purpose in the walls 8 and 11. Through the apertures 13 in the lower member 12 air may enter the chamber between the platform 6, hood 5 and wall 8 to cool the mechanism contained therein. The heated currents of air pass out of this chamber through the passages 13 formed in the upper member 12. The members 12 are formed with passages 15 which extend parallel to the member 3. These passages permit the passage of air currents through the annular space between the walls 8 and 11 in a direction parallel to the axis of the casing walls.

Hoods or guards 16 are secured to the outer casing wall to prevent the entrance of dirt or moisture into the interior of the casing wall 8 through the passages 13. The members 12 may be secured to the inner casing by rivets 17 and the outer casing wall may be secured to the inner casing wall by screws 18 which pass through the two walls and through separating washers 19. As shown, the upper end of the casing wall 11 terminates some distance below the adjacent portion of the hood member 5 which serves as a guard to prevent dust or moisture from entering the space between the walls 8 and 11.

Chambered member 20, shaped like an in-

verted bell and preferably formed of some material having good heat conductivity such as sheet brass or copper, is secured to the platform 6. In the construction shown the upper end of the member 20 is formed with a cylindrical portion 20' which embraces the lower end of the casing wall 8 and is secured to the platform 6 by the screws 10. The lower end of the bell-shaped member 20 which is closed has secured to it, as by screws 22, the upper and positive non-consuming electrode 23 of the lamp which in the construction shown and described comprises a cylindrical block of metal 24. The metal of the block 24 is preferably formed of some material which is a good conductor both of heat and electricity, and is not readily oxidized. The lower end of the electrode 23 may advantageously be formed of silver. In the construction shown a disk 25 formed of silver is secured to the lower end of the block 24. Diametrically opposed slots 26 are formed in the member 20 at its lower end. Through these slots project the horizontal arms or L-shaped members 27. Each member 27 comprises a horizontal arm and a downwardly extending arm. The inner ends of the members 27 are pivotally connected to a cross-head 27' located within the chambered member 20 which is connected to the lower end of a plunger or core 28 formed of magnetic material, the upper end of which extends into the tubular member 3 in which it has a sliding fit. To the upper end of the member 28 is connected one end of a coiled flexible conductor 29, the other end of which is secured to the member 3 by a clamping screw 30.

An extension 30' of the outer casing wall 11 supports the upper end of the hollow member 31, shaped like a truncated cone, both ends of which are open. The member 31 surrounds the member 20 from which it is separated by a space annular in cross-section. To the lower end of the member 31, which is about on a level with the lower end of electrode 23, are secured at diametrically opposed points, arms 32. The arms 32, which are similar to each other, are L-shaped each comprising an upper vertical portion and a lower horizontal portion. The lower horizontal portions are bent to form a socket in which is secured the lower electrode 33 of the lamp by screws 34 which connect the members 32 together.

The electrode 33 is in line with the electrode 23 from which it is separated by the arc length. As shown, gravity holds the lower ends of the downwardly extending arms of the members 27 in engagement with the periphery of the electrode 33 with some force when the parts are in the position shown in the drawings. When the winding is energized, however, the core 28 is attracted and the lower ends of the members 27

are elevated above the lower end of the electrode 23. Curved scrapers 35, each extending about half way about the electrode 23, are carried by the members 27. As the core 28 rises and falls the scrapers 35 remove from the cylindrical surface of the electrode 23 any material which may have been deposited thereon by the arc.

The lower end of the extension 30' supports in any suitable manner, as by means of screws 36, a globe 37 which surrounds and incloses the arc. An aperture 38 may be formed in the lower end of the globe through which air may enter which, when heated by the arc, passes up through the annular space between the members 20 and 31, and through the annular space between the casing walls 8 and 11 and out into the atmosphere over the upper end of the casing wall 11 and below the hood 5. This air serves both to steady the arc and to carry the arc products out of the lamp.

The hood 5 carries binding posts or terminals 35' and 36'. A conductor 39 connects the terminal 35' which is the positive terminal of the lamp to one terminal of the winding 7. The other terminal of the winding 7 is connected to the member 3 by a conductor 40. As shown the member 3 is electrically connected to the electrode 23 through the platform 6 and member 20 and to the auxiliary electrode comprising the arms 27 through the flexible conductor 29, core 28, and cross-head 27'. A conductor 41 connects the negative terminal 36' of the lamp with one of the arms 32. As shown the conductor 41, which is suitably insulated, passes down through the space between the casing walls 11 and 12 and through the space between the members 20 and 31.

If the lamp shown is to be operated in a constant potential circuit a steadying resistance in series with the lamp will ordinarily be necessary. If the lamp is to be operated in a series circuit an automatic cut-out will ordinarily be necessary. The steadying resistance or cut-out may be located either within or without the lamp structure. As these devices are well known to those skilled in the art I have not thought it necessary in the present case to illustrate either of them.

It will be observed that when the lamp is put in circuit current begins to flow between the terminals through a circuit which includes the negative electrode and the members 27, cross-head 27', core 28 and winding 7. This will energize the winding, whereupon the core 28 will be raised and the members 27 will be moved away from the lower electrode, thus starting the arc. The movement of the core 28 is sufficient to raise the lower end of the members 27 above the lower end of the electrode 23. As the lower ends of the members 27 move above the

lower end of the electrode 23 the upper end of the arc drawn between the electrode 33 and the member 27 is automatically transferred from the member 27 to the electrode 23.

5 The lower electrode is so made that its decrease in length produced by the arc is very slow. I have obtained excellent results by making the lower electrode in the form of an iron tube filled with a mixture of iron, titanium, magnesium and chromium oxids and chromite. The relative proportions of these materials may be varied considerably. I have advantageously used a composition containing approximately 80 parts of natural titaniferous magnetite containing about 15 9% of the titanium oxid, 4 parts of magnesium oxid and 16 parts of chromium oxid  $\text{Cr}_2\text{O}_3$ . The magnesium and chromium oxids serve to greatly decrease the consumption of the electrode from the action of the arc. The arcing end of an electrode having the composition above described is apt to become covered with a film or layer which is a poor conductor of electricity when cold. The 25 members 27, however, which engage the iron tube or sheath inclosing the electrode at some distance below the arcing end of the electrode, make good electrical connections with the electrode. The arc drawn between the 30 side of electrode 33 and the auxiliary electrode soon warms the arcing end of the electrode 33 up so that its conductivity becomes fairly good, and the arc ordinarily plays from the side of the electrode 33 for not 35 more than a second or so at starting. I prefer to make electrode 33 with a diameter about twice that of the ordinary carbon electrode. When so formed and with the composition described above, a period of one 40 hundred and sixty hours or thereabout will be required to produce an electrode consumption of one-fourth of an inch with the ordinary arc currents which I prefer to employ. The lamp disclosed will operate satisfactorily while the arc increases one-fourth 45 of an inch from its length at starting. The attendant who must necessarily inspect the lamp from time to time to clean the globe, etc., and see that everything is working 50 properly, may raise the lower electrode at intervals to compensate for its consumption by manipulating the screws 34.

An electrode of the composition above described when employed as a negative electrode gives a luminous or flaming arc which emits an efficient amount of white light. Moreover the arc flame is quite stable. The construction hereinbefore described is simple, reliable, compact, and easily made. It 60 will be obvious, however, that changes may be made in the form of the lamp disclosed without departing from the spirit of my invention, and that certain features of my invention may be employed, without a corresponding use of other features. 65

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an arc lamp, the combination of a pair of stationary main electrodes one of which is a conductor of the first class and the other composed of a material which is liable to become a conductor of the second class under the action of the arc, but is incased in a conductor of the first class, with a movable auxiliary electrode in permanent electrical connection with the first named stationary electrode, and means for moving it from engagement with the inclosure of the second stationary electrode a distance greater than the distance between the two stationary electrodes. 70 75 80

2. In an arc lamp, a pair of fixed main electrodes one of which is a conductor of the first class and the other composed of a material which is liable to become a conductor of the second class under the action of the arc, but is incased in a conductor of the first class, a movable member actuated by the passage of current through the lamp, and an auxiliary electrode connected thereto engaging the casing of the second named stationary electrode when no current is flowing through the lamp and moved away from the said casing when current passes through the lamp. 85 90 95

3. In an arc lamp, a pair of main electrodes, an auxiliary electrode comprising a pair of members pivoted for relative movements and arranged to engage on opposite sides of one of the main electrodes when the lamp is in the out-of-service condition, and means for moving said members away from said latter main electrode and toward the other main electrode when the lamp is put into service. 100 105

4. In an arc lamp, a tubular member, a platform carried at one end thereof, a winding surrounding said tubular member, a core of magnetic material movably mounted within said tubular member, a pair of main electrodes secured below and in line with said tubular member, and an auxiliary electrode comprising a member pivotally secured to said core and engaging the more remote of said electrodes when the lamp is in the out-of-service condition. 110 115

5. In an arc lamp, a pair of main electrodes between which an arc extends when the lamp is in service, a core movable in line with the arcing points of said electrodes, and an L-shaped member having one end pivoted to the core and the other end normally held by gravity in engagement with the side surface of one of said electrodes. 120

6. In an arc lamp, a tubular member, a platform secured to said tubular member, a chambered member having its upper end secured to said platform, an electrode secured to the lower end of said chambered member, a movable core movably extending into 125 130

said tubular member, one or more L-shaped members each having one end pivotally secured to said core, said L-shaped members extending through slots formed for the purpose in said chambered member, and a second electrode secured below the first, said L-shaped members being so arranged that their lower ends engage the outer surface of said second electrode when the core is in one position and are separated therefrom when the core is in another position.

7. In an arc lamp, a non-consuming electrode, a consuming electrode, a member movable in a direction parallel with the axis of said non-consuming electrode and located above said non-consuming electrode, an auxiliary electrode carried by said member and arranged to engage the side of said consuming electrode when the lamp is in an inoperative condition, and means controlled by the passage of current through said lamp for moving said auxiliary electrode away from said consuming electrode.

8. In an arc lamp, a chambered member, a non-consuming electrode secured to the under side thereof, a second electrode located below said non-consuming electrode, a movable member located in said chamber, an L-shaped member having one end pivoted to said member, the parts being so proportioned and arranged that the other end of said L-shaped member is held by gravity in engagement with the side of the lower electrode when the lamp is in the out-of-service condition, and means controlled by the passage of current through said lamp for moving said L-shaped member out of engagement with said lower electrode.

9. In an arc lamp, a tubular member, a stationary upper electrode, a lower electrode composed of material liable to become a second class conductor under the action of the arc but incased in a conductor of the first class and fixed below said upper electrode, a winding surrounding said tubular member, a core cooperating therewith sliding in said tubular member, and a device connected to said core for starting an arc between the casing of the lower electrode and the upper electrode and shifting it from the casing to the body of the lower electrode.

10. In an arc lamp, a pair of electrodes out of contact with each other, a movable arc starter for starting an arc between said electrodes, and a device operated by the movement of said arc starter for removing from one of said electrodes material which may have been deposited thereon from the arc.

11. In an arc lamp, a pair of main electrodes, an auxiliary electrode, means for causing it to move into and out of engagement with the side of one of said electrodes to start an arc therefrom, and a device actuated by the movements of said auxiliary electrode for removing from the other of

said main electrode material which may have been deposited thereon from the arc.

12. In an arc lamp, an electrode from the end of which an arc extends in the normal operation of the lamp, a second electrode having a portion adapted to engage the side of the first mentioned electrode when the lamp is in the out-of-service condition, and means for moving said second electrode in a direction parallel to the length of the first mentioned electrode to move said portion away from said first mentioned electrode thereby drawing an arc between the electrodes when the lamp is connected in circuit.

13. In an arc lamp, a casing comprising two walls one within the other, said walls being separated from each other and formed with openings or passages through them, a spacing member between said walls formed with one set of passages which register with said passages in said walls, and with another set of passages which lead from the space between said walls at one side of said member to the space between the walls at the opposite side of said member.

14. In an arc lamp, a casing comprising two walls one within the other, said walls being separated from each other to form a chimney space through which the arc products may pass and being provided with openings or passages through them, said member between said wall being formed with one set of passages which register with said passages in said walls and with another set of passages which lead from the space between said walls at one side of said member to the space between said walls at the opposite side of said member.

15. In an arc lamp, a pair of main electrodes between which an arc extends when the lamp is in service, an electromagnet and a core-armature for the same movable in line with the axis of said electrodes, and an L-shaped member having one end pivoted to the core and in permanent electrical connection with one electrode, and the other end normally held by gravity in engagement with the side surface of the other electrode.

16. In an arc lamp, a pair of stationary main electrodes, a movable auxiliary electrode in permanent electrical connection with one of said main electrodes and normally engaging the other electrode at a region removed from its main arcing surface, and means for moving it from this position to a position which is separated from the second named electrode by a distance greater than the distance between the main arcing surfaces of the fixed electrodes.

In witness whereof, I have hereunto set my hand this 29th day of April, 1905.

JOHN T. H. DEMPSTER.

Witnesses:

BENJAMIN B. HULL,  
HELEN ORFORD.

J. T. BEECHLYN.  
 BALL CLUTCH FOR ARC LAMPS.  
 APPLICATION FILED JULY 17, 1908.

948,293.

Patented Feb. 1, 1910.

Fig. 1

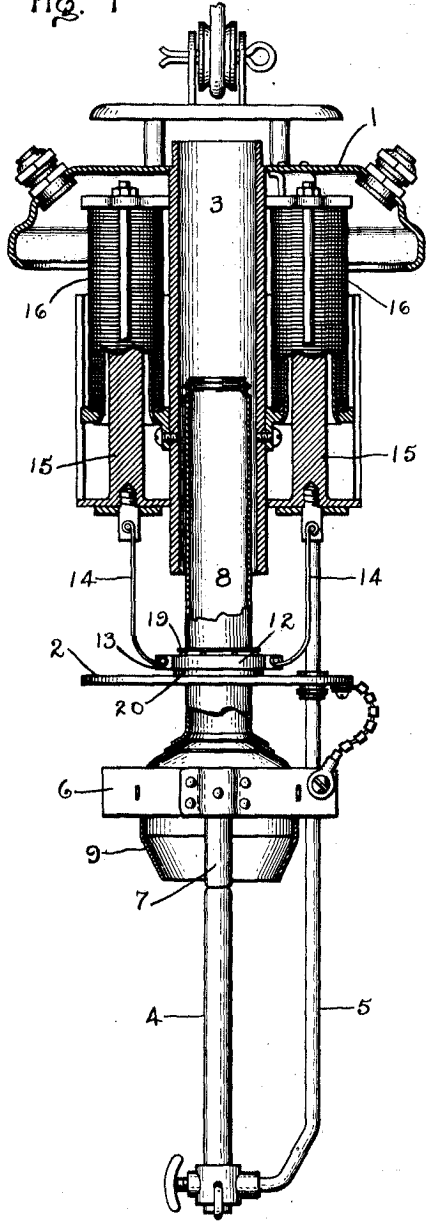


Fig. 2

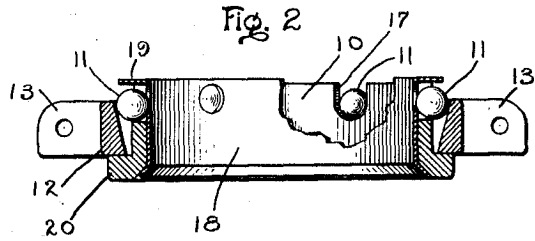


Fig. 3

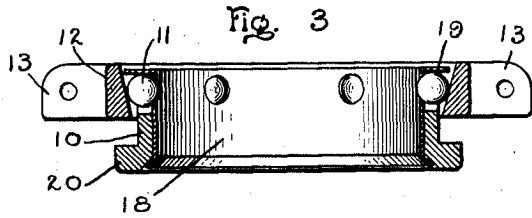


Fig. 4

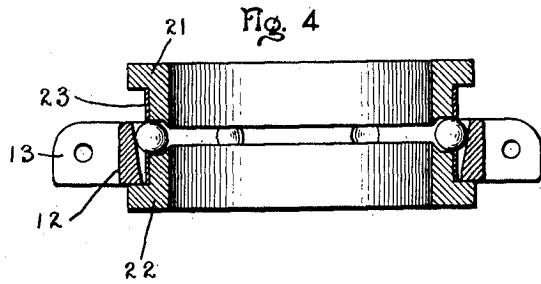
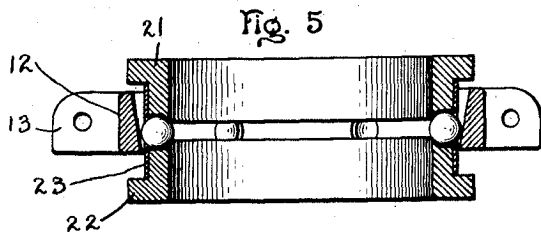


Fig. 5



WITNESSES:

*Allen Corfield*  
*Frank J. Dore*

INVENTOR

JOHN T. BEECHLYN.

BY *Alfred D. Damm*

ATTY.

# UNITED STATES PATENT OFFICE.

JOHN T. BEECHLYN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## BALL-CLUTCH FOR ARC-LAMPS.

948,293.

Specification of Letters Patent.

Patented Feb. 1, 1910.

Application filed July 17, 1908. Serial No. 443,975.

To all whom it may concern:

Be it known that I, JOHN T. BEECHLYN, a subject of the King of Denmark, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Ball-Clutches for Arc-Lamps, of which the following is a specification.

This invention relates to electric arc lamps, and especially to those in which a flaming or luminous arc is employed. Such lamps produce quantities of fumes which are carried up through the lamp mechanism by a chimney.

It has been found convenient to utilize the chimney to support the upper electrode, and since this is the negative, which consumes and requires to be fed downward at intervals, the chimney is made in two sections, the upper one stationary, and the lower one movable and telescoping into the upper. The mechanism for feeding the upper electrode is applied to the movable section of the chimney, and the present invention aims to improve the clutch by which said chimney is lifted to strike the arc, the object being to provide a clutch which will engage with the chimney on all sides simultaneously so as to prevent it from canting to one side and jamming in the upper section, and also to prevent any possibility of the two electrodes getting out of line. In pursuance of these ends I provide an annular clutch consisting of a collar sliding easily on the chimney and carrying a plurality of loose balls, held inside of a conical clutch ring, by which they are forced inwardly into gripping relation with the chimney when said ring is lifted by the lamp magnet. The result is that the chimney is engaged at a plurality of points around its circumference, and at all such points simultaneously, so that the chimney is lifted vertically, and the negative electrode is kept accurately in line with the lower electrode.

In the accompanying drawing, Figure 1 is a sectional elevation of a flaming arc lamp embodying my invention; Figs. 2 and 3 are diametrical sections of one form of ball clutch, open and closed, respectively; and Figs. 4 and 5 are similar views of a modified form of clutch.

The lamp frame comprises a hood 1, a tripping platform 2 and a central tubular mem-

ber 3 which is secured to the hood and constitutes the upper or stationary section of the lamp chimney, its upper end terminating above the hood. The lower positive electrode 4 is supported by a holder 5 beneath the platform 2, in axial alinement with the chimney 3. The negative electrode 6 is preferably in the form of a horizontal bar, having a depending extension 7 axially alined with the lower electrode. The bar 6 is carried within the lower end of the lower section 8 of the chimney which is arranged to telescope inside the upper section. This movable or floating section preferably has a bell-shaped portion 9 at its lower end below the platform 2, while its body portion extends up through an opening in said platform, and into the upper section 3, whose lower end is located a little distance above said platform.

Surrounding the floating chimney just above the platform is the ball clutch which constitutes my present invention. A tripping collar 10 encircles the chimney loosely so that the chimney can easily slide through it. Balls 11 are located in openings in the collar so that they can project through into contact with the chimney. They can be forced inwardly by an annular follower or clutch ring 12 surrounding the collar, whose inner surface is that of an inverted frustum of a cone. The clutch ring has lugs 13 to which are attached links 14 connecting said ring with the cores 15 of the solenoids 16 constituting the regulating electromagnet which is in circuit with the electrodes.

A convenient mode of securing the balls in place in the collar is shown in Figs. 2 and 3. The collar has a plurality of U-shaped slots or notches 17 in its upper edge, in which the balls rest. A sheet metal retainer or bushing 18 has holes registering with said notches, and an outwardly projecting flange 19 at its upper end. Its lower end is swaged outwardly to engage a chamfer in the lower end of the collar. An external flange 20 at this end of the collar keeps the clutch ring always in engagement with the balls even when in its lowest position, with the clutch open; while the flange 19 on the retainer prevents them from escaping over the top of the ring.

When the lamp is not burning, the floating chimney drops down until the upper

electrode rests upon the lower electrode. In this position the tripping collar rests on the platform, and the clutch ring on the flange 20, with the balls backed away from the chimney, the parts being as shown in Fig. 2. When the current is turned on, the regulating solenoids are energized and, acting through the cores and links, lift the clutch ring. Its conical inner surface crowds the balls inwardly against the floating chimney until the friction is sufficient to grip said chimney. By this time the ring has reached the position shown in Fig. 3 and upon being lifted still farther by the solenoids, it carries up with it the collar, the chimney and the upper electrode, thereby striking the arc. Inasmuch as the ring acts upon all the balls simultaneously, the floating chimney is engaged on all sides at the same instant, so that there is no tendency to tilt it to one side and cause it to bind in the upper section 3. Moreover it is maintained in a central vertical position, so that as it feeds down by the weakening of the solenoids the upper electrode keeps accurately in line with the lower one.

Figs. 4 and 5 show a modified construction of the clutch in which the collar is made in two parts, an upper one 21 and a lower one 22, arranged with a space between their beveled adjacent edges to receive the balls, and connected by an outer sheet metal jacket or ball retainer 23 having holes to space the

balls apart. The operation is the same as in the case of the clutch shown in Figs. 2 and 3. 35

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an arc lamp, the combination with a floating chimney carrying the upper electrode, of a clutch comprising a tripping collar loosely encircling said chimney and having a flange at its lower end, a plurality of balls engaged by and projecting through said collar, a ball retainer applied to said collar and having holes to receive said balls, a regulating electromagnet, and a clutch ring supported on the flange of the tripping ring and connected with the electromagnet so that it can be actuated thereby for forcing said balls into simultaneous engagement with said chimney. 40 45 50

2. A ball clutch for flaming arc lamp chimneys, comprising a tripping collar having slots in its upper edge, balls in said slots, a sheet metal ball retainer inside of said collar having an external flange at its upper end, and a clutch ring surrounding said collar and having an inverted conical inner surface. 55

In witness whereof, I have hereunto set my hand this fifteenth day of July, 1908. 60

JOHN T. BEECHLYN.

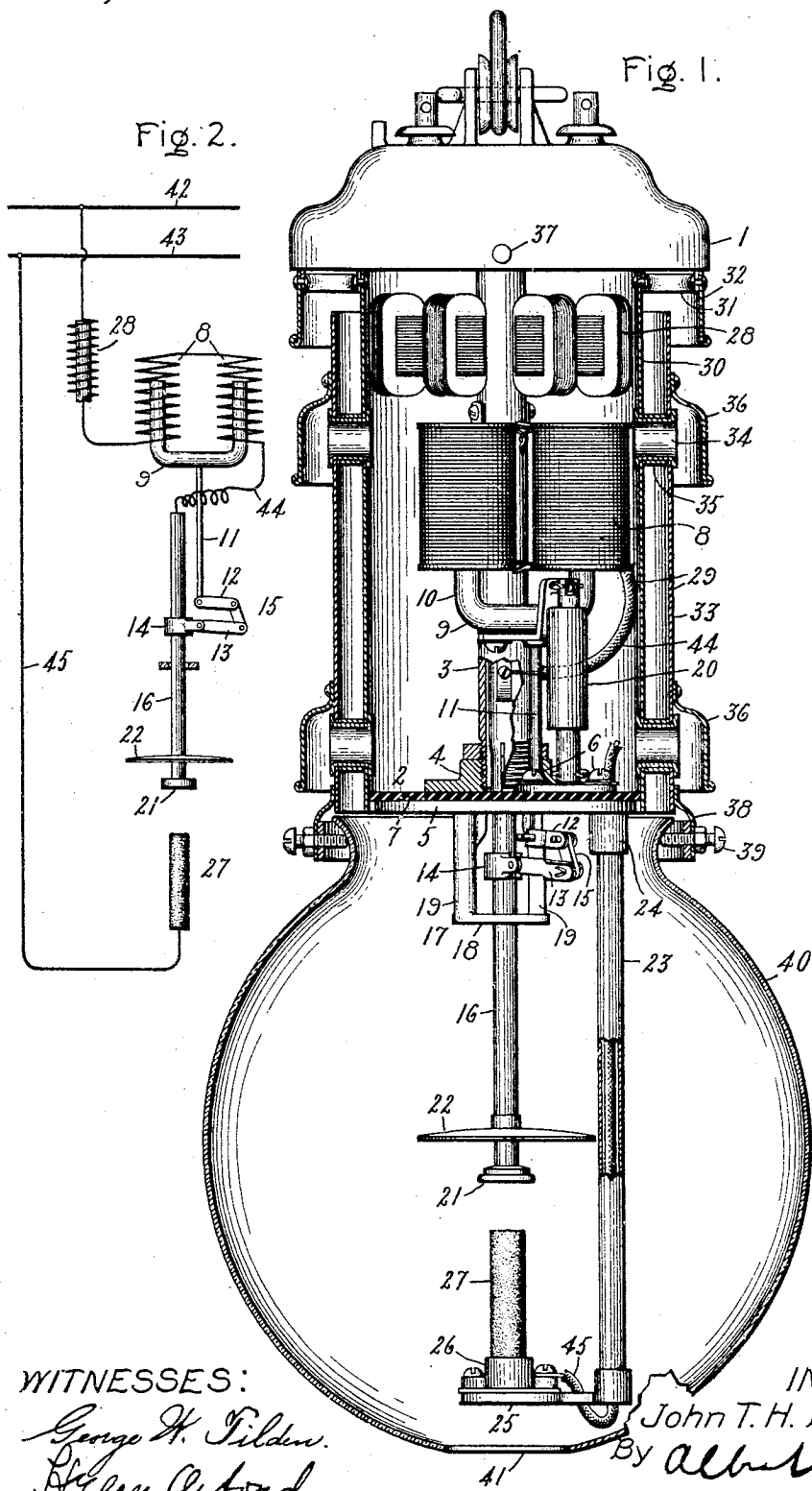
Witnesses:

JOHN A. McMANUS, Jr.,  
ROBERT SHAND.

J. T. H. DEMPSTER.  
 ARC LAMP.  
 APPLICATION FILED MAY 27, 1905.

949,353.

Patented Feb. 15, 1910.



WITNESSES:

*George H. Tilden.*  
*Helen Clifford*

INVENTOR.

*John T. H. Dempster,*  
 By *Albert S. Davis*  
 Att'y.



# UNITED STATES PATENT OFFICE.

JOHN T. H. DEMPSTER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

949,353.

Specification of Letters Patent. Patented Feb. 15, 1910.

Application filed May 27, 1905. Serial No. 262,550.

*To all whom it may concern:*

Be it known that I, JOHN T. H. DEMPSTER, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My present invention comprises certain features of construction and arrangement for the improvement of arc lamps.

My invention is particularly intended for use in an arc lamp of the type in which a negative electrode formed of or containing some material giving a luminous arc is employed in conjunction with a non-consuming positive electrode, though my invention in its broader aspect is not limited to any particular form of arc lamp.

In carrying out my invention I employ a movable positive electrode which moves toward and away from the negative electrode as the electrical condition of the arc changes. I attach to the movable electrode a device which serves to increase the heat radiating capacity of the electrode. This device may also be arranged to have a damping effect on the movements of the positive electrode as the electrical condition of the lamp varies by a sort of a dashpot action.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of my invention, however, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated and described one of the many forms in which my invention may be embodied.

Of the drawings, Figure 1 is an elevation with parts broken away and in section of an arc lamp; Fig. 2 is a diagrammatic representation of the circuit arrangements of the lamp.

Referring to the drawings, 1 represents the lamp top or hood which is connected to the main platform 2 of the lamp by a tubular post 3. The platform 2 comprises a member 4 directly secured to the lower end of the post 3, an annular member 5 secured to the member 4 by screws 6, and a disk 7 of insulating material between the members 4 and 5. It will be understood that the screws

6 are arranged so that they do not electrically connect the members 4 and 5.

A pair of solenoid magnetizing coils 8 are secured to the post 3 with their axes parallel to each other and to the post. A U-shaped core or armature cooperates with these coils, the legs 10 of the core extending axially into the coils. An operating rod or bar 11 is secured to the yoke of the armature 9. The lower end of the bar 11 which extends through the platform 2 has adjustably secured to it an arm 12. The pawl member 13 of a clutch 14 is pivotally secured to the arm 12 by a link 15. The yoke member of the clutch 14 surrounds a bar or rod 16 which is formed of some metal such as copper which is a good conductor both of heat and electricity. The upper end of the bar 16 projects into the tubular post 3.

A bracket 17 comprising a lower horizontal portion 18 and two vertical portions or legs 19 is secured by bolts to the platform 2, but is insulated from the member 5. The portion 18 of the bracket 17 is provided with an aperture through which the member 16 passes. The portions 18 also serve as a stop against which the yoke of the clutch rests when the coils 8 are deenergized. In this case the outer end of the pawl 13 is depressed and the member 16 is free to move through the yoke of the clutch. When, however, the outer end of the pawl 13 is raised as by the attraction of the armature 9 by the coils 8, the member 16 is locked between the pawl 13 and the yoke member of the clutch 14. One member of a dashpot 20 is secured to the armature 9; the other member of the dashpot is secured to the platform 2.

The lower end of the member 16 is provided with a button or portion 21 which may be an integral enlargement of the rod 16, or may be a separate piece secured to the end of the rod. The button 21 forms the positive electrode of the lamp. A short distance above the button 21 is secured a disk 22 formed of some material such as sheet copper which is a good conductor of heat. The disk 22 may advantageously be in the neighborhood of 3 inches in diameter.

The upper end of a post 23 is secured in a socket 24 provided for the purpose on the under side of the member 5. The lower end of the post 23 supports a bracket 25 which

L. W. PULLEN.  
 ARC LAMP.  
 APPLICATION FILED MAY 24, 1906.

958,828.

Patented May 24, 1910.

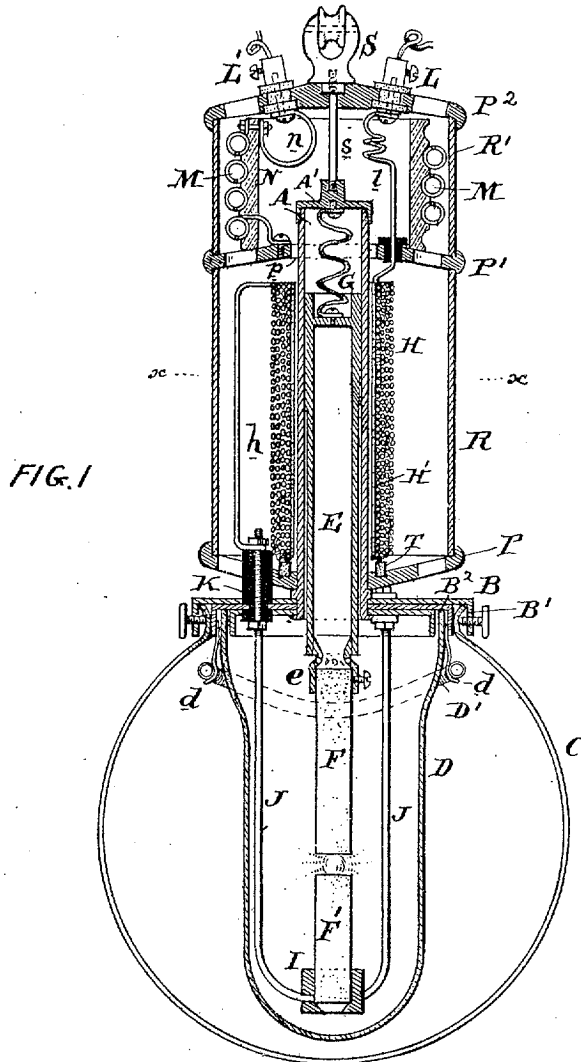


FIG. 1

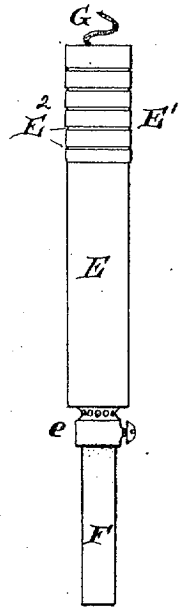
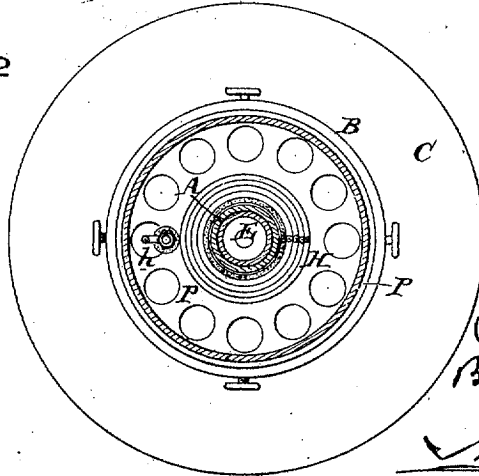


FIG. 3

FIG. 2



Attest  
*R. M. Kilby.*  
*M. H. Bates.*

Inventor  
*Leon W. Pullen.*  
 By *his atty*  
*[Signature]*

# UNITED STATES PATENT OFFICE.

LEON W. PULLEN, OF CAMDEN, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS,  
TO WALDRON CLARK MANUFACTURING COMPANY, A CORPORATION OF NEW YORK.

ARC-LAMP.

958,828.

Specification of Letters Patent.

Patented May 24, 1910.

Application filed May 24, 1906. Serial No. 318,445.

To all whom it may concern:

Be it known that I, LEON W. PULLEN, of the city and county of Camden and State of New Jersey, have invented an Improvement in Arc-Lamps, of which the following is a specification.

My invention has reference to arc lamps and consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings which form a part thereof.

The object of my invention is to produce an arc lamp which shall be simple in construction, inexpensive to make, compact and small in size and efficient and steady in action.

My invention consists of certain features of construction which are set out in the specification and more particularly defined in the claims.

More specifically referring to the details of construction and with reference to the drawings:—Figure 1 is a sectional elevation of an arc lamp embodying my improvements; Fig. 2 is a sectional plan view of the same on line  $x-x$  of Fig. 1; and Fig. 3 is an elevation of the carbon holder and plunger.

A is a tube preferably of nonmagnetic material and is closed at the top by a cap  $A'$ . The lower end of the tube A is secured to the globe holder B which comprises three flanged disks of different diameters placed one upon the other so as to form two concentric annular channels  $B^1$   $B^2$  between their flanges. The outer globe C is clamped in the outer annular channel  $B^1$  by suitable clamping screws. The inner globe D has the top enlarged in diameter and its upper edge ground and fitted into the inner annular channel  $B^2$ . This globe D is held in position by any suitable means, that shown comprising a band of coiled wire constituting an endless coil spring  $D'$  which presses upward against the enlargement of the globe and is hooked over two hooks  $d$   $d$  depending from the head B. It will be evident that this construction forms of the globe and the tube A a practically air tight chamber.

E is a plunger or piston adapted to reciprocate in the tube A and is provided at the bottom with a carbon holder or clamp  $e$  in which the upper carbon F is carried. This plunger is made of iron so as to be

magnetically influenced by the solenoid H surrounding the tube A. The lower carbon F' is carried in a holder I near the bottom of the inner globe, and this holder is held by three wire brackets J which are united at the bottom by the holder and secured at their tops to the globe holder plate by insulation and clamping devices, the insulation K of one of these being extended sufficiently high to bring the terminal of the wire J well up within the case R where it is connected by a wire  $h$  with the solenoid H.

P is a lower head of iron and is sleeved upon the tube A and rests close to the globe holder B. This head P is perforated for ventilating purposes and carries slate studs T upon which the solenoid H rests to insure perfect insulation. The coils of the solenoid H are wound upon an asbestos tube H' to thoroughly insulate it from the tube A. In this way the solenoid has no supporting parts which can burn or char and consequently short circuiting is guarded against.

Supported upon the lower head P is the cylinder R of the case and this is made of iron also. Resting upon this cylinder R is an upper head P' of iron and the center of this is bored out sufficiently so as to surround but not touch the tube A. This forms an annular air gap  $p$  between the parts A and P' for purposes to be referred to later on.

R' is a cylinder arranged above the head P' and also constituting part of the case. The cylinder R' may be of brass or non magnetic material. P<sup>2</sup> is the top cap of the case and rests upon the cylinder R'.

All of the parts P R P' R' and P<sup>2</sup> are held together by the tube A, a stud  $s$  extending through the cap P<sup>2</sup> and a nut S screwed upon the stud. Any other suitable manner of uniting the several parts may be employed if so desired.

The solenoid has one of its terminals connected by a wire  $z$  with the binding post L above the cap P<sup>2</sup>.

The plunger E is connected by a flexible conductor G with the cap of the tube A so that electric current may be conveyed to the plunger from the cap P through a stud  $s$  cap A' and conductor G.

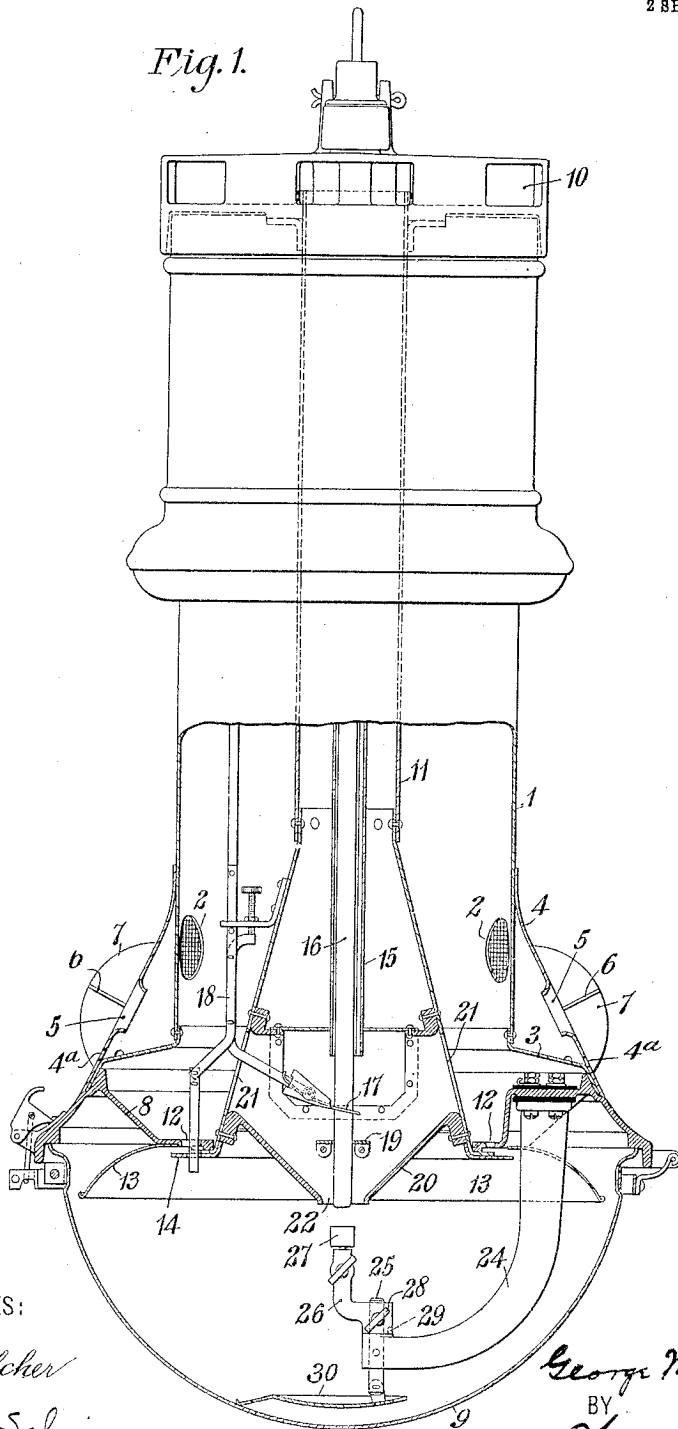
Arranged within the cylinder R' and between the cap P<sup>2</sup> and head P' is the resistance M and this consists of the usual coils

964,664.

Patented July 19, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

*C. L. Belcher*

*Otto S. Schairer*

INVENTOR

*George M. Little*

BY

*Osley E. Carr*  
ATTORNEY

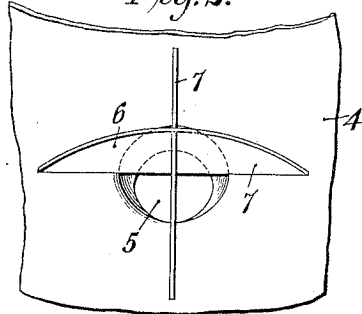
G. M. LITTLE.  
ARC LAMP.  
APPLICATION FILED MAY 6, 1907.

964,664.

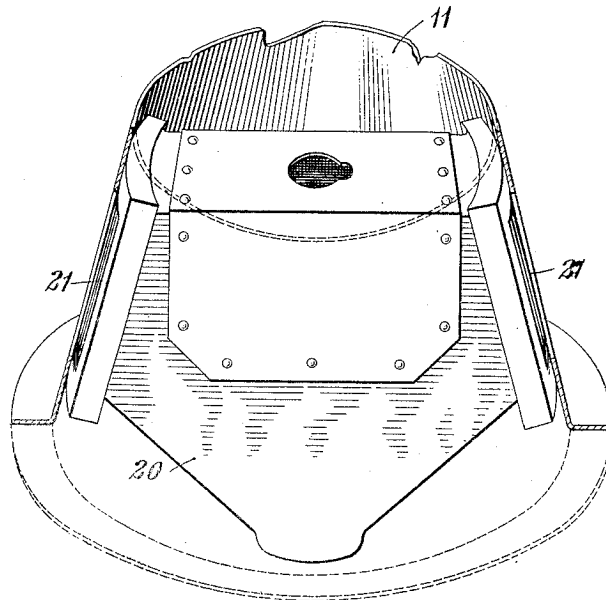
Patented July 19, 1910.

2 SHEETS—SHEET 2.

*Fig. 2.*



*Fig. 3.*



WITNESSES:

*C. L. Belcher*  
*Otto S. Schairer.*

INVENTOR

*George M. Little*

BY

*Hubert E. Carr*  
ATTORNEY

# UNITED STATES PATENT OFFICE.

GEORGE M. LITTLE, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## ARC-LAMP.

964,664.

Specification of Letters Patent. Patented July 19, 1910.

Application filed May 6, 1907. Serial No. 372,178.

To all whom it may concern:

Be it known that I, GEORGE M. LITTLE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Arc-Lamps, of which the following is a specification.

My invention relates to arc lamps, and particularly to such lamps as embody composition electrodes from which vapors or fumes are emitted that become incandescent in the arc and enhance the luminosity thereof.

The object of my invention is to so construct and arrange the parts of a lamp of the character indicated that the light may not be unduly obstructed or the most effective distribution thereof interfered with, and so that trimming, cleaning and repairing of the lamp may be done conveniently and expeditiously.

A further object of the invention is to so provide for the ventilation of lamps of the character indicated that reflectors may be employed to obtain a desired or effective distribution of the light.

When composition electrodes containing other materials than carbon are employed in arc lamps for the purpose of increasing the luminosity of the arc and improving the quality of the light, fumes and vapors are usually emitted at the arc which, unless properly disposed of, may deposit and condense upon the parts of the lamp so as to obstruct more or less of the light and otherwise interfere with the successful operation of the lamp. For this reason, it is very desirable and quite essential that the lamp be so constructed that a continuous draft of air will be directed through it for the purpose of conveying the fumes and vapors to the exterior, and, further, so that such deposits as form in spite of these precautions may be readily removed. The present invention facilitates and insures the passage of air into the lamp and permits the use of a reflector for obtaining a desired or the most effective distribution of the light, the incoming drafts of clean air being directed over the surface of the reflector to prevent the fume and vapor-laden atmosphere from coming into contact therewith.

Figure 1 of the accompanying drawings is a view, partially in elevation and par-

tially in section, of a lamp that embodies my invention. Fig. 2 is a face view of one of the deflectors upon the exterior of the lamp, and Fig. 3 is a view, partially in perspective and partially in section, of some of the parts of the lamp shown in Fig. 1.

The lamp is provided with a casing the main cylindrical member 1 of which has a plurality of screened apertures 2 near its lower end. Secured to the lower end of the member 1 is a slightly flared annular sheet metal piece 3, extending upwardly from the outer edge of which is a frusto-conical sheet metal ring 4 that joins the main member 1 above the apertures 2. The ring 4 is provided with a plurality of apertures 5, the walls of the apertures being bent inwardly. Extending across the apertures 5 are sets of angularly disposed vanes 6 and 7 that serve to direct drafts of air into the lamp regardless of the direction of the wind, the inwardly projecting walls of the intake apertures 5 being of material assistance in effecting this result. By reason of the peculiar construction and arrangement of these parts, snow and water are prevented from entering the casing through the apertures 2 and are drained off through small apertures 4<sup>a</sup> that are provided in the ring 4 adjacent to the part 3.

The lower and outer edges of the members 3 and 4 fit against a ledge at the upper edge of an annular partition 8, to the lower edge of which is clamped a transparent globe 9 that provides an arc chamber below the partition. Supporting the partition 8 and extending upwardly through the lamp from the opening therein and communicating with the exterior through openings 10 in the top of the lamp, is a flue or chimney 11, the lower end of which is enlarged and flared to assist in collecting the fumes and vapors that are given off at the arc.

The partition 8 is provided, near its inner edge, with a plurality of apertures 12 through which air, that is taken into the lamp through the apertures 5 and 2 is admitted to the arc chamber. Secured to the lower face of the partition 8, with its inner edge just outside of the apertures 12, is a concave reflector 13 the surface of which is kept clean by drafts of air which are admitted into the arc chamber through the apertures 12 and are guided by means of an annular deflector 14 at the lower end of the

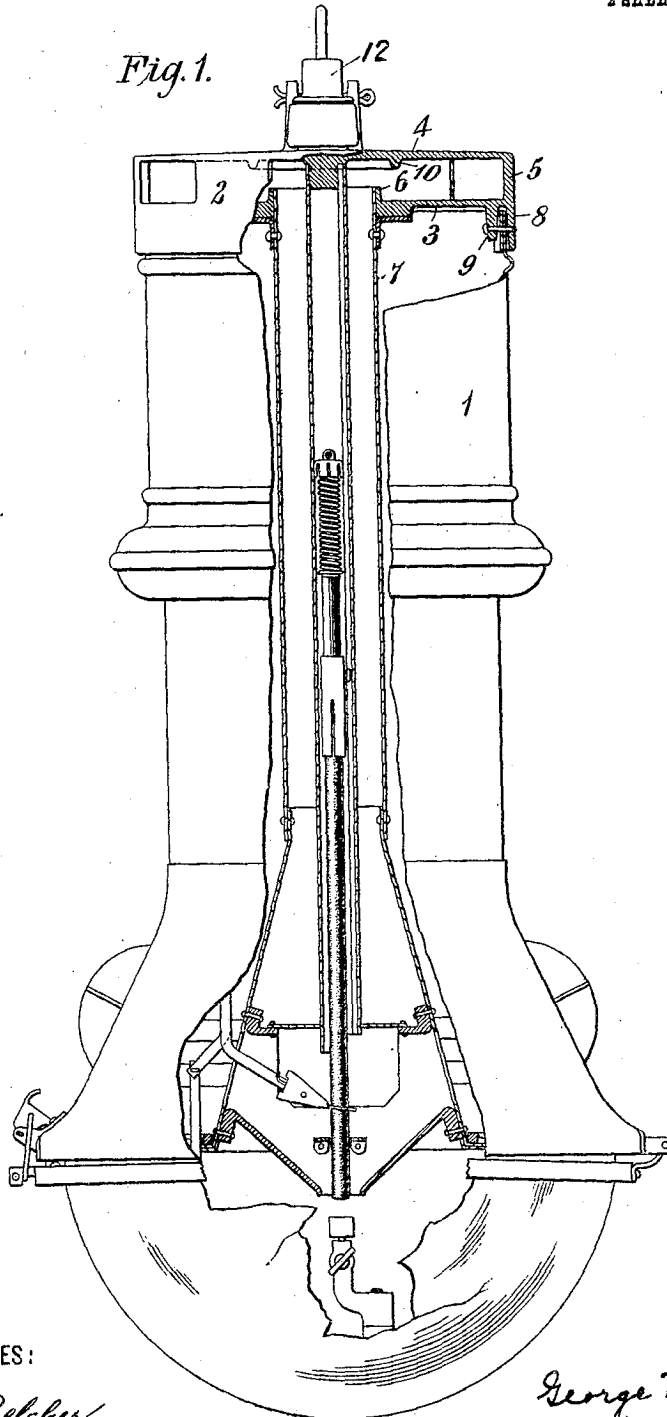
G. M. LITTLE.  
CASING FOR ARC LAMPS.  
APPLICATION FILED MAY 6, 1907.

964,666.

Patented July 19, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

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INVENTOR

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ATTORNEY

G. M. LITTLE.  
 CASING FOR ARC LAMPS.  
 APPLICATION FILED MAY 6, 1907.

964,666.

Patented July 19, 1910.

2 SHEETS—SHEET 2.

Fig. 2.

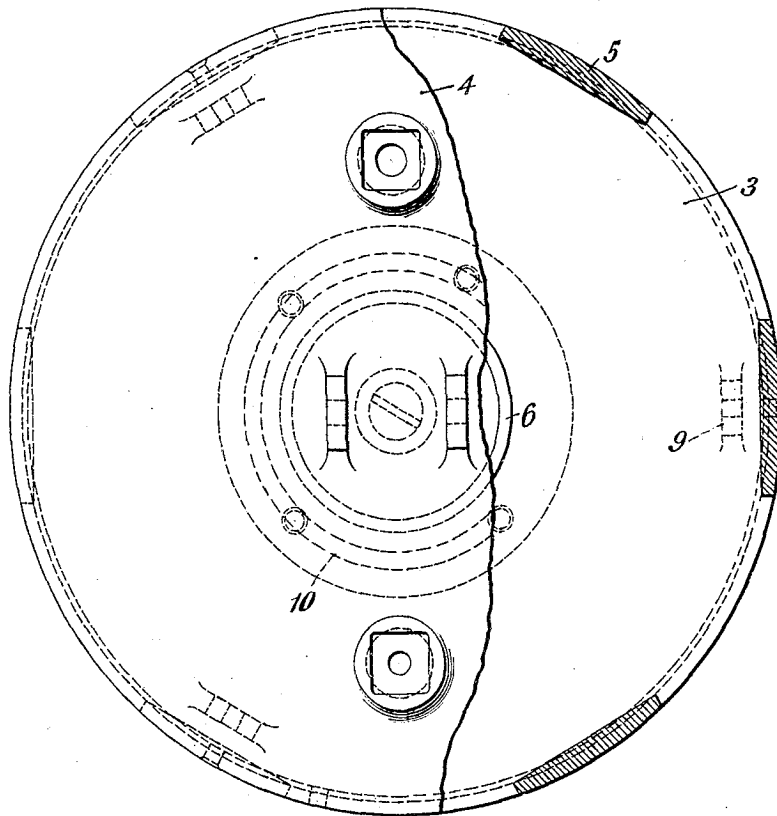
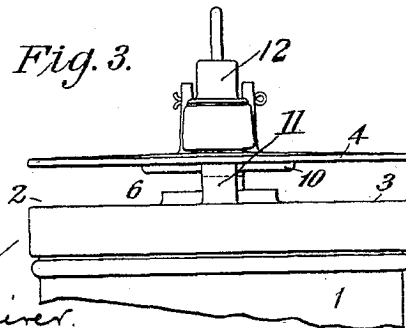


Fig. 3.



WITNESSES:

*C. L. Belcher*  
*Otto S. Schairer*

INVENTOR

*George M. Little*

BY

*Asley Carr*  
 ATTORNEY



# UNITED STATES PATENT OFFICE.

GEORGE M. LITTLE, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## CASING FOR ARC-LAMPS.

964,666.

Specification of Letters Patent. Patented July 19, 1910.

Application filed May 6, 1907. Serial No. 372,181.

To all whom it may concern:

Be it known that I, GEORGE M. LITTLE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Casings for Arc-Lamps, of which the following is a specification.

My invention relates to arc lamps, and particularly to means for ventilating the same.

The object of my invention is to provide especially effective means whereby drafts may always be directed outwardly from the top of the lamp.

When certain kinds of electrodes, such, for instance, as those containing the magnetic oxid of iron and the oxids of titanium and chromium, are used in arc lamps, it is necessary to provide means for removing from the interiors of the lamps the vapors and fumes that are given off at the arc in order to prevent the same from condensing and depositing upon the operating parts, or upon other parts in such a manner as to obscure more or less of the light given by the lamps. The means usually employed comprises a chimney the lower end of which opens to the exterior near or at the top of the lamp. It is evidently essential that drafts be always directed outwardly through this chimney and that drafts be prevented from blowing down the chimney, and to this end the structure constituting the subject-matter of the present application has been provided.

My invention is illustrated in the accompanying drawings, Figure 1 of which is a view, in elevation, of a lamp constructed in accordance therewith, some of the parts being broken away for the sake of clearness of illustration. Fig. 2 is a plan view of the top casting of the lamp shown in Fig. 1, a portion thereof being broken away, and Fig. 3 is a sectional view of a portion of the lamp embodying a modification of the structure shown in Fig. 1.

An arc lamp casing 1 is provided with a top or cap 2 comprising two plane and parallel plates 3 and 4 that are spaced apart and secured together at their edges by a plurality of vanes 5, the edges of the plates being in exact vertical alinement and the inner edges thereof being square or only very slightly rounded. The lower plate 3 is pro-

vided, upon its upper face, with a cylindrical flange 6 that surrounds an aperture through which a chimney tube 7 projects, the upper end of the tube being flush with the upper face of the flange 6. The chimney tube 7 extends downwardly through the lamp, its lower end portion being enlarged and flared and its open end being just above where the arc occurs between the electrodes. The upper plate 4 is provided, upon its lower face, with an annular boss or ring 10 of somewhat larger diameter than the flange 6, this ring being for the purpose of assisting in preventing downward drafts. The top 2 is provided with a flange 8 that extends downwardly over the upper end of the casing 1 and between which and a plurality of lugs 9 the casing is secured, the outer cylindrical face of the flange being in vertical alinement with the edges of the plates 3 and 4. The plates 3 and 4 are also connected by cylindrical sleeves 11 through which the leads to the lamp project, terminals 12 being provided upon the exterior of the lamp.

In order to effectually prevent downwardly-directed drafts in the chimney when the wind blows between the plates of the top, it is highly desirable that the upper end of the chimney tube project above the plate 4, as shown, and also that the opposing faces of the plates 3 and 4 be substantially parallel. The vanes 5 are provided for the purpose of breaking the force of heavy winds that may blow upon the lamp so as to reduce the amount of air that may circulate through the top, but may be omitted, if desired, as shown in Fig. 3. The plates 3 and 4 are made of the same diameter and their edges are placed in vertical alinement in order that upward or downward drafts may not be directed into the top, and to this end, the edges of the plates are also made square or are only slightly rounded. I have found that, by the observance of the principles herein outlined, the drafts will always be directed outwardly from the top of the casing, and downward drafts will be effectually prevented.

I claim as my invention:

1. The combination with a casing, of a top therefor comprising two spaced parallel plates of the same diameter the edges of which are joined by vanes, and a chimney tube that projects through and above the lower plate.

R. FLEMING & C. A. B. HALVORSON, JR.

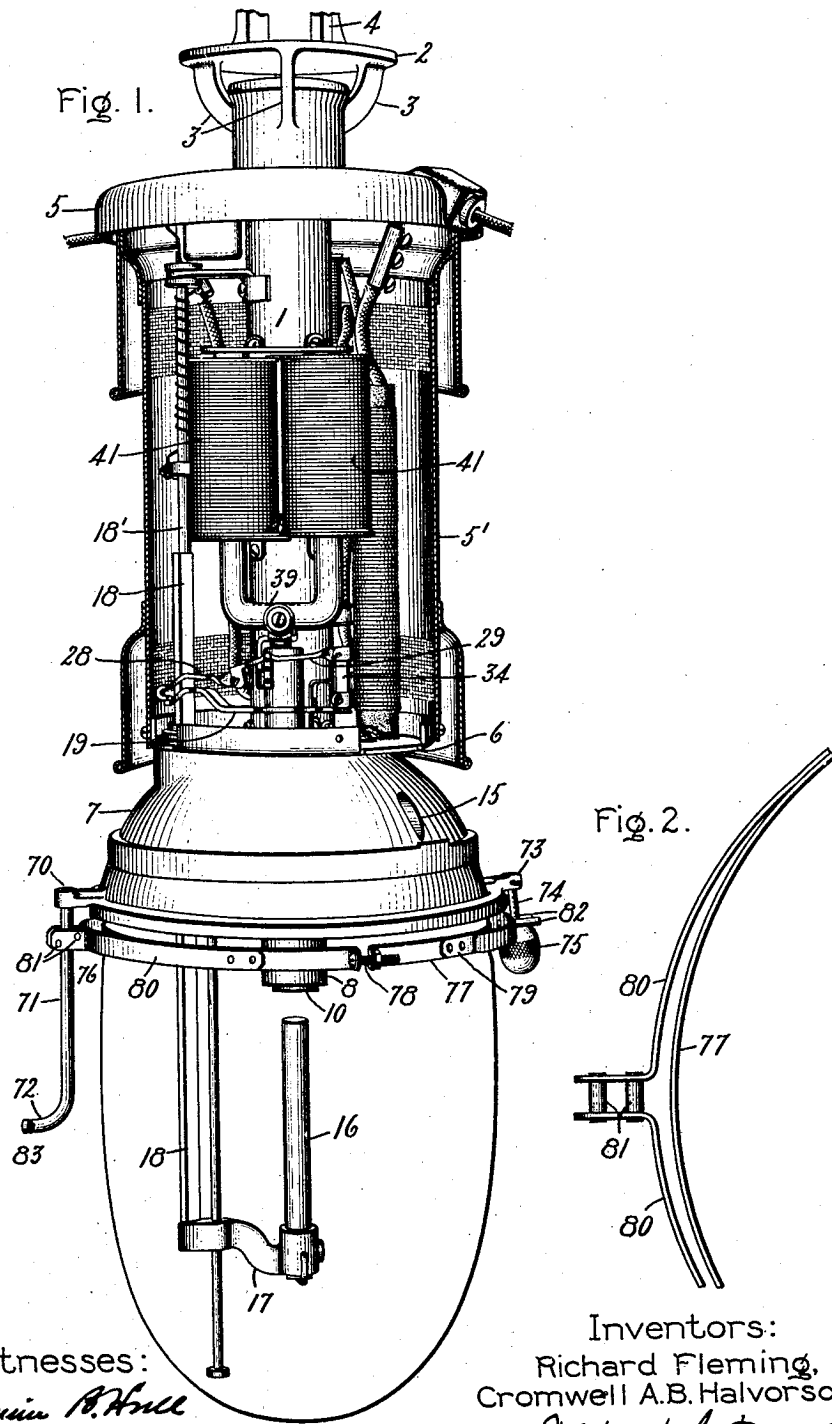
ARC LAMP.

APPLICATION FILED JAN. 16, 1906.

964,691.

Patented July 19, 1910.

3 SHEETS—SHEET 1.



Witnesses:  
*Benjamin B. Hull*  
*Allen Oxford*

Inventors:  
Richard Fleming,  
Cromwell A.B. Halvorson Jr.  
by *Albert B. Davis*  
Att'y.

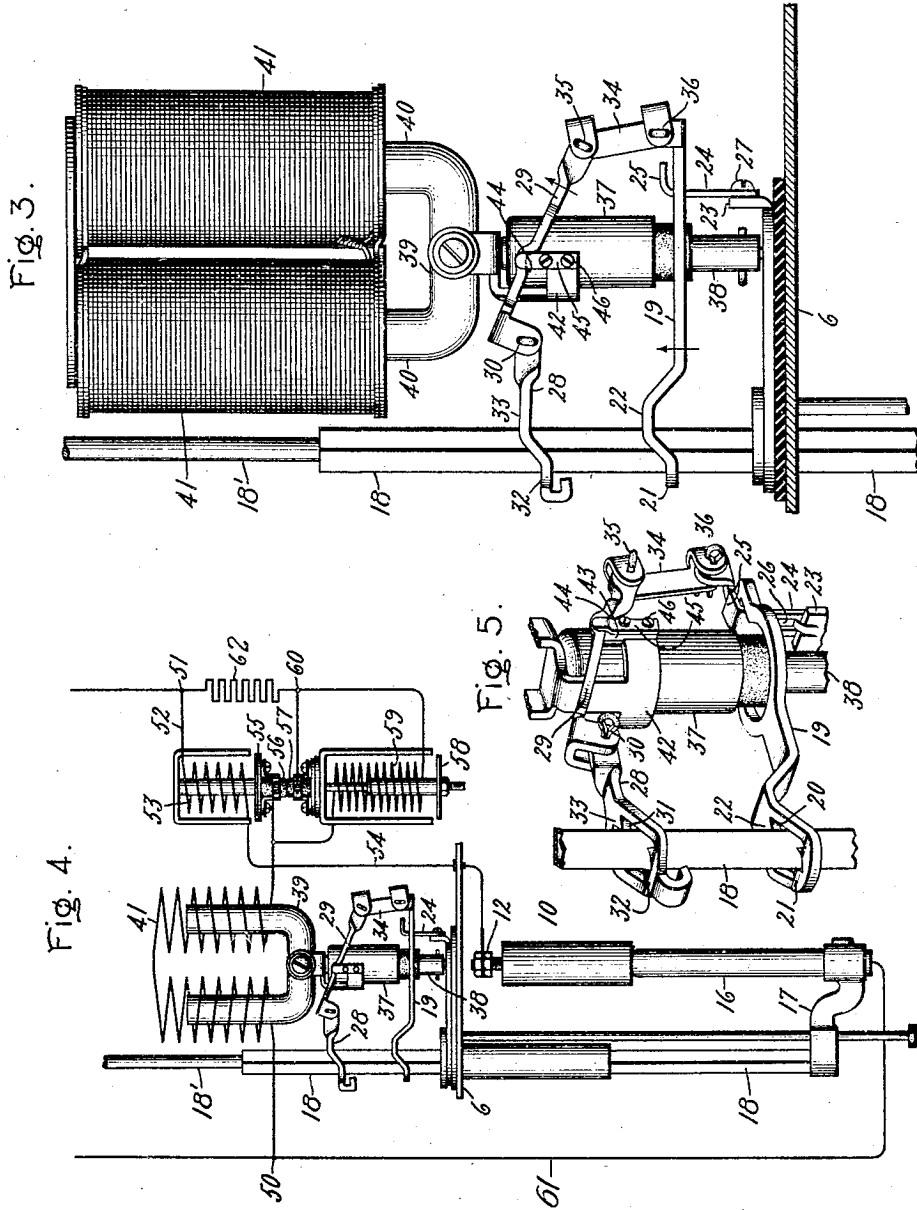
R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED JAN. 16, 1906.

964,691.

Patented July 19, 1910.

3 SHEETS—SHEET 2.



Witnesses:  
*Benjamin B. Hall*  
*Allen Orford*

Inventors:  
Richard Fleming,  
Cromwell A.B. Halvorson Jr.,  
by *Albert S. Davis*  
Att'y.

R. FLEMING & C. A. B. HALVORSON, JR.

ARC LAMP.

APPLICATION FILED JAN. 16, 1906.

964,691.

Patented July 19, 1910.

3 SHEETS—SHEET 3.

Fig. 6.

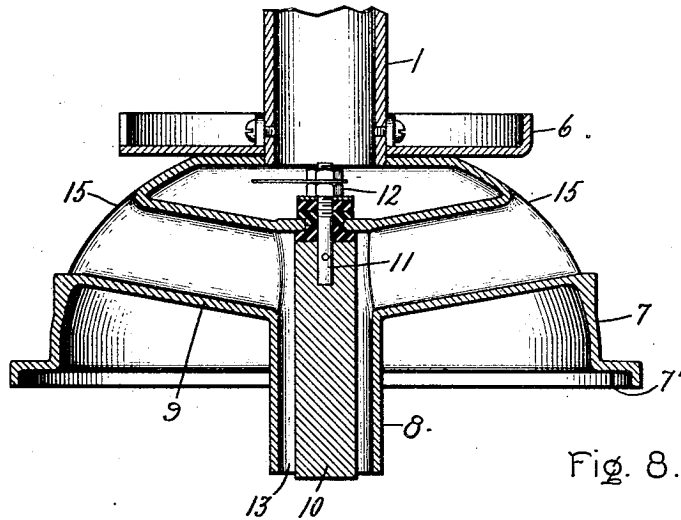


Fig. 8.

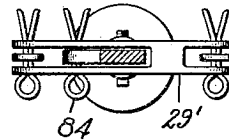
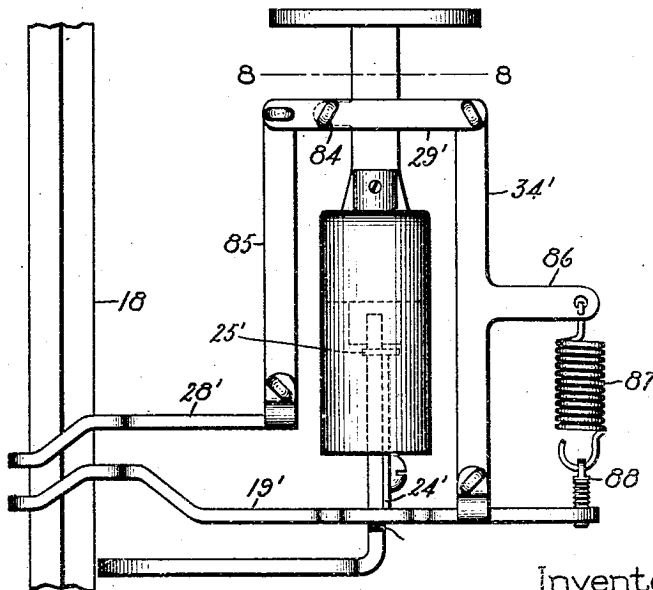


Fig. 7.



Witnesses:

*Thomas B. Hull*  
*Allen Oxford*

Inventors:

Richard Fleming,  
Cromwell A.B. Halvorson Jr.,

by *Albert S. Davis*  
Att'y.

# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS,  
ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

964,691.

Specification of Letters Patent. Patented July 19, 1910.

Application filed January 16, 1906. Serial No. 296,304.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, JR., citizens of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

Our present invention relates to arc lamps in which the character of the electrodes employed is such that a flaming or luminous arc is obtained. In such lamps the major portion of the illumination comes not from the tips of the arcing electrodes heated to incandescence as in the ordinary carbon arc lamp, but from the arcs between the electrodes. The increased length of such arcs, the comparative slowness with which the electrodes which produce them are consumed if the electrodes are suitably chosen, and other differences between luminous arcs and the ordinary carbon arc render it desirable to employ feeding mechanisms for the electrodes in these lamps differing from those heretofore employed with lamps employing carbon electrodes.

With the electrodes employed for the production of luminous or flaming arcs the arc products are not practically all permanent gases as in the case of carbon electrodes, but on the contrary contain much matter which condenses to a solid form when cooled to a temperature approaching that of the atmosphere. On this account it is necessary to provide means for disposing of the arc products.

Our present invention comprises certain features of construction and arrangement, particularly of electrode feeding mechanisms and smoke or fume disposing means particularly adapted for use in luminous or flaming arc lamps, though some of them are not exclusively limited to such use.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of our invention and the advantages possessed by it, reference may be had to the accompanying drawings and descriptive matter in which we have illustrated and described one of the forms in which our invention may be embodied.

Of the drawings, Figure 1 is a perspective

view of an arc lamp with the casing in section; Fig. 2 is an elevation of a portion of a globe holder; Fig. 3 is an elevation on a larger scale than Fig. 1 showing the clutch mechanism in the position occupied at the instant of starting the arc; Fig. 4 is a diagram illustrating the circuit arrangements and the position of the feeding mechanism at the instant at which the electrodes are in contact; Fig. 5 is a perspective view illustrating the clutch mechanism of Figs. 1, 3 and 4; Fig. 6 is a sectional elevation illustrating the arrangement of the upper electrode and the hood or fuse box surrounding it; Fig. 7 is an elevation illustrating a modified form of clutch mechanism in the normal working and out of service position; and Fig. 8 is a plan view on the line 8-8 of Fig. 7.

In the drawings, 1 represents a tubular member which forms the backbone of the arc lamp structure and serves as a chimney through which the arc products pass. This member may be one integral mechanical element or may be formed in sections. A flat disk like hood or shield 2 is secured above the end of the chimney proper by arms 3. Bracket arms 4 extending from the upper side of the hood form a means by which the lamp may be supported. The feeding mechanism of the lamp is located between a hood or platform 5 secured to and surrounding the chimney 1 near its upper end and a platform 6 secured to and surrounding the member 1 at or near its lower end. The lamp mechanism located between the platforms 5 and 6 is inclosed by a suitable casing 5' which may be of any well known form.

To the lower end of the member 1 is secured in any suitable manner a bell shaped hood or member 7. The member 7 has an opening in its upper end which communicates with the interior of the chimney member 1. A hollow tubular member 8 is supported in the member 7 in line with the chimney 1 by means of a hollow support 9 which in the form shown is integral with the member 8 and the hood proper. In the construction illustrated, the lower end of the member 8 projects some distance below the lower end of the hood proper.

The upper electrode 10 of the lamp is secured within the hollow member 8 with its lower end projecting slightly below the

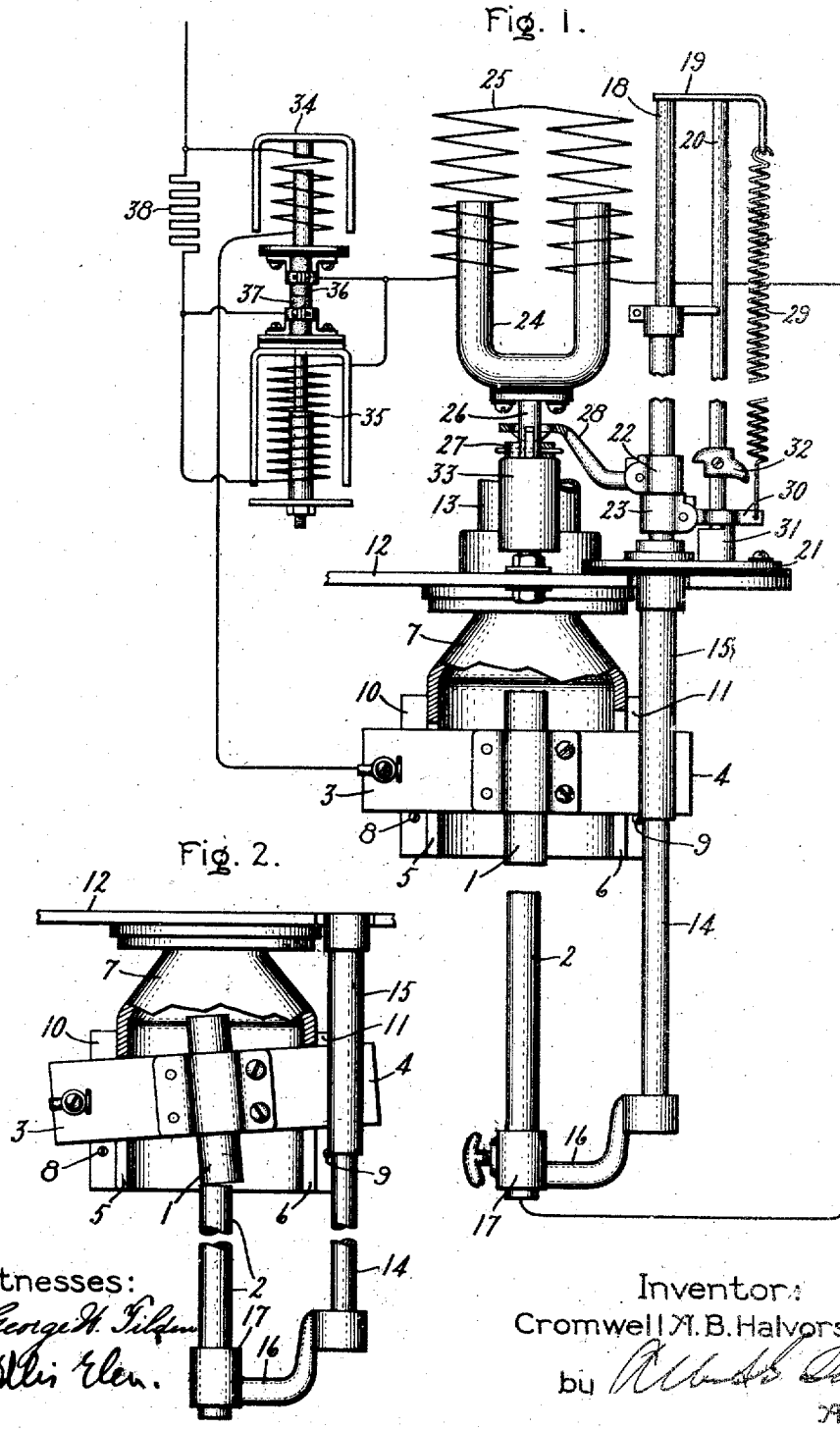
C. A. B. HALVORSON, JR.

ABC LAMP.

APPLICATION FILED JAN. 28, 1909.

973,653.

Patented Oct. 25, 1910.



# UNITED STATES PATENT OFFICE.

CROMWELL A. B. HALVORSON, JR., OF SAUGUS, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

973,653.

Specification of Letters Patent.

Patented Oct. 25, 1910.

Application filed January 28, 1909. Serial No. 474,721.

To all whom it may concern:

Be it known that I, CROMWELL A. B. HALVORSON, Jr., a citizen of the United States, residing at Saugus, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention has reference to improvements in arc lamps of the kind in which for the establishment of the arc and also at intervals during the feeding operation the two electrodes are brought together and are then separated to the arcing distance. In these lamps cathodes are employed which in consuming yield the gases or vapors which maintain the arc, while the anode is, as a rule, a piece of metal of good conductivity of heat and electricity and which, theoretically speaking, is not at all consumed, although in practice it has proved to become consumed at a slow rate. The cathode is usually made of a material which becomes fused at the arcing end, forming there a little pool from which the arc springs. In these lamps the inconvenience has been experienced that when the cathode, which is usually the lower electrode, is forcibly brought into contact with the anode the two electrodes become superficially fused together, and this phenomenon is spoken of as the freezing together of the electrodes. When this happens the electrodes are held together so tenaciously that they cannot be separated and the arc cannot be established, and the unduly great amount of current which is thus allowed to pass is liable to injure the parts.

My invention is designed to overcome this freezing together of the electrodes, and it consists in a peculiar mounting of one of the electrodes in such manner that when during the feeding operation the two electrodes are brought forcibly together one of these electrodes is caused to turn upon a pivotal point so as to be out of alinement with the other electrode, whereby the arcing faces of the two electrodes form a considerable angle with each other so as to be out of contact throughout their greater part, where-

by the fused pool of the cathode is prevented from sticking to the anode or, if it has temporarily stuck to the same, is again peeled off before the pool has congealed and hardened. All this will more fully appear from the following description with reference to the accompanying drawing, in which:

Figure 1 represents an elevation of the operating mechanism of an electric arc lamp of the kind to which my invention applies, with its circuit connections and electromagnets diagrammatically indicated, the electrodes being shown separated; and Fig. 2 represents a portion of the same lamp mechanism in the condition after the electrodes have come into contact.

Like numerals of reference indicate like parts throughout the drawing.

In these drawings, 1 and 2 represent respectively a positive and a negative electrode of a luminous arc lamp. The positive electrode 1 is shown in the form of a copper rod having wing-like extensions 3, 4 which pass through diametrically opposite slots 5, 6 in the walls of the fume box 7. In these slots the wings of the electrode can move up and down but normally rest upon cotter pins 8, 9 which pass through flanges 10, 11 extending from the fume box near the slots 5, 6. When the wings of the electrode 1 rest upon these cotter pins the wings themselves are horizontal and the electrode 1 is vertical and in axial alinement with the electrode 2, as shown in Fig. 1. In accordance with my invention the slots 5, 6 are made of unequal length, as is clearly indicated in the drawing in which the slot 6 is shown as extending considerably higher up into the wall of the fume box than the slot 5, and this is the special feature of my invention as embodied in a lamp of the character here illustrated, as will appear farther on.

The platform 12 supports the fume box and from the upper side of the platform extends a chimney 13, it being understood that the platform has a wide opening registering with the upper end of the fume box and with the lower end of the chimney. In the drawing the chimney is shown as broken off.

The negative electrode 2 is shown sup-

J. T. H. DEMPSTER.  
ELECTRIC ARC LAMP.  
APPLICATION FILED MAY 31, 1902.

981,248.

Patented Jan. 10, 1911.

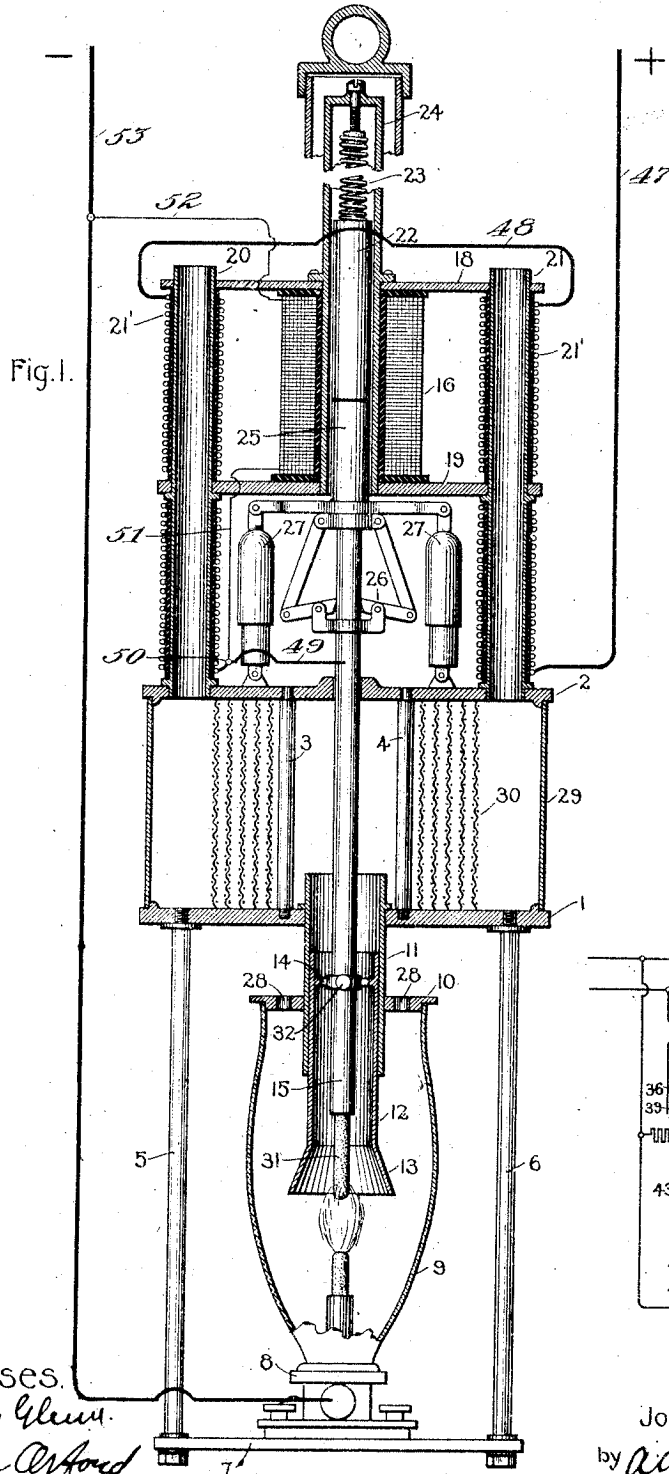
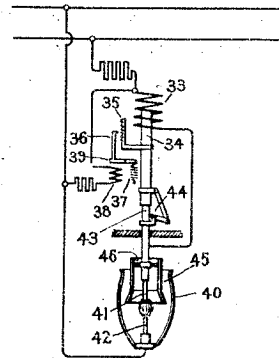


Fig. 1.

Fig. 2.



Witnesses.  
*J. Ellis Glenn*  
*Helen Arford*

inventor:  
John T.H. Dempster.  
by *Albert G. Davis*  
Atty.



# UNITED STATES PATENT OFFICE.

JOHN T. H. DEMPSTER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC-ARC LAMP.

981,248.

Specification of Letters Patent. Patented Jan. 10, 1911.

Application filed May 31, 1902. Serial No. 109,583.

*To all whom it may concern:*

Be it known that I, JOHN T. H. DEMPSTER, a subject of the King of Great Britain, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

My present invention is intended more especially for use in connection with arc lamps of that type in which the arc is rendered luminous by reason of the materials used in forming the electrodes, though it is to be understood of course that various features thereof are of value in other relations as well.

Among other features my invention provides means for preventing discoloration of the arc-inclosing globe by reason of solid matter given off from the arc in the form of smoke, and also provides means whereby the arc is rendered steady and free from the flickering or swaying back and forth ordinarily present in luminous arcs of any considerable length.

The novel features which I believe characterize my invention I have pointed out with particularity in the appended claims while in the following description, which is to be taken in connection with the accompanying drawings, I have set forth in detail certain embodiments of my invention.

In the drawings Figure 1 represents one embodiment of my invention and Fig. 2 a modification.

The frame-work of the lamp, as indicated in Fig. 1, includes two disks or plates 1 and 2 held apart from each other and secured in position by means of connecting rods such as at 3 and 4. From the lower plate 1 depend two rods 5 and 6 carrying at the lower end a cross-bar 7 which supports the lower carbon holder 8 and the arc-inclosing globe 9 carried thereby. This arc-inclosing globe, which is closed at the bottom by its reception in the holder 8, is provided at its top with a perforated cover 10. This cover is of cylindrical shape provided with a recess on its outer edge so as to fit into the top of the arc-inclosing globe. Passing through the central portion of the cover is a draft tube or chimney member 11, the lower end of which projects downward a certain distance through the cover, and the upper end of

which fits closely into an opening in the plate 1 of the lamp frame and is provided with a flange resting on the plate 1 for holding it in place. Another draft tube or chimney member 12 provided at its lower end with a flared portion 13 forms a telescopic joint with the tube 11. The flared tube, which may be made of metal, or of mica or glass so as to transmit light, is supported by small cross-bars or rods 14 from the rod 15 carrying the upper electrode. This upper electrode rod 15 is controlled by means of a solenoid 16 carried by cross bars 18 and 19 fixed to the upper ends of two tubes 20 and 21 which pass through openings in the upper plate 2 of the lamp frame and are secured thereto as indicated.

Within the solenoid 16 is a tubular armature 22 of magnetic material suspended by means of a spring 23 the upper end of which is secured at the top of an upwardly extending tube 24 carried by the cross-bar 18. The lower end of the armature is fastened to a tubular guiding member 25 of non-magnetic material to which are attached the clutch mechanism 26, the dash-pots 27 and the upper electrode rod 15 as indicated. The rod 15 moves in the tubes 22 and 25 according as its position is adjusted relatively to the clutch 26.

The purpose of the telescopic tube 11 and 12 above referred to is to produce an upward draft of air in the vicinity of the arc and to cause this draft to be directed inward in the neighborhood of the top of the arc so as to steady the latter and prevent it from swaying or flickering back and forth. To provide an ingress for the air, a series of holes or perforations may be made in the top plate or cover 10, two of these holes being indicated in the cross-sectional view at 28. The heat of the arc causes the air to ascend through the telescopic tubes, thus producing a partial vacuum which draws fresh air into the arc-inclosing globe through the openings 28 in the cover of the globe. The heated air draft rising through the telescopic tubes removes from the same and from the upper electrode such solid products of combustion as may have been deposited thereon, and largely prevents the deposition of such products of combustion in these places. In this manner the dropping of such products into the globe is prevented and at

the same time the tip of the upper electrode is cleaned of insulating deposits thereon, which, if allowed to form, would make the starting of the arc uncertain. The air draft then enters the space between the plates 1 and 2 constituting portions of the lamp frame-work and this space is inclosed by a cylindrical shell 29 so as to form a chamber from the upper portions of which extend the tubes 20 and 21. The heated air passes from this chamber up through the tubes, thereby inducing a strong down-draft along the walls of the globe through the openings 28 and producing an up-draft along the upper end of the arc, which has the effect before mentioned of preventing flickering or swaying back and forth of the arc and also of withdrawing from the arc-inclosing chamber, from the chimney entrance and from the tip of the upper electrode, as soon as they are formed, any fumes or solid products given off by the arc in the form of smoke or otherwise. If it is desired to prevent the lamp from giving off this smoke into the outer atmosphere, I provide the chamber between plates 1 and 2 with what I may perhaps term filtering screens indicated in cross-section at 30. As the upward draft in the lamp draws the smoke or other products from the arc through the meshes of these screens the solid matter is deposited therein, thereby preventing the same from being discharged by the air drafts into the outer air. In order to render the upward draft through the telescopic tubes the most effective in steadying the arc, I find that the upper floating electrode 31 should be arranged with reference to the flared portion 13 of the tube 12 so that the lower ends are substantially on a level with each other. This may be readily done by adjusting the position of the tube by a set-screw or other device 32 acting on the electrode carrying rod 15.

45 It will be observed that in the construction described, the draft tube or chimney passage, which may be regarded as formed of sections consisting of the tubes 20, 21, chamber 29, and tubes 11 and 12, extends from the upper end of the arc to practically the top of the lamp structure. This arrangement insures a relatively powerful natural draft which is found to be highly beneficial in lamps of this character.

55 I prefer to use electrodes formed with a mixture of the magnetic oxid of iron as a basis with certain other materials such as magnesia, borates or the like. As electrodes of this composition waste away very slowly it is seldom necessary to vary the adjustment of the upper electrodes with respect to the tube 12. Indeed it may happen that the upper electrode instead of wasting away may actually increase slightly in length.

65 In the lamp which I have described above,

the solenoid 16 is intended to be connected in shunt with the electrodes, which electrodes are provided with a series resistance to steady the arc. This series resistance 21' may be wound about but insulated from the draft-tubes 20 and 21 and by heating the same increase the draft. The circuit connections of this lamp are as follows: The current enters the lamp by conductor 47, proceeds to and through the resistance windings 21', 21', which are connected by conductor 48, and then by flexible conductor 49 to the upper electrode, then to the lower electrode, and out by conductor 53. At a point 50 the conductor 49 is tapped by a shunt-wire 51, which leads to one terminal of solenoid 16, the other terminal of which is connected by shunt wire 52 with the out-going conductor 53.

The use of the shunt feed lamp of the type described has the advantage that the electrodes do not drop together when the current is shut off which with certain compositions of electrodes is distinctly an advantage, since if they were permitted in many cases to remain together while hot, they would weld or stick fast to each other. When electrodes of this character are used in lamps with the ordinary series regulating magnet, I provide means for maintaining the electrodes separated when the current is turned off and such an arrangement is indicated in Fig. 2. In this figure the series controlling magnet is indicated at 33 and its armature carrying the mechanism of the upper electrode at 34. Attached to the armature, or a part carried thereby, is a small rack 35 having a pawl or lock 36 urged toward it by means of a spring 37 and away from it by means of a magnet 38 acting upon its armature 39 which carries the pawl. This magnet may be in a circuit of extremely high resistance across the electrodes of the lamp so that if the arc goes out or if the current is turned off the magnet is de-energized and the pawl 36 by engaging the rack 35 prevents the electrodes from falling together. In Fig. 2 I have also shown a modification of the arc-steadying draft mechanism. In this figure the arc-inclosing globe is indicated at 40 within which are the electrodes 41 and 42. The upper floating electrode is carried by a rod 43 acted upon by the clutch mechanism 44 of the lamp and this rod in its turn carries a flared tube either of metal or glass, the lower end of which is about on a level with the lower end of the electrode 41. This flared tube is supported from the electrode rod 42 by means of radially arranged members or pins 46 so as to permit the heated air from the arc to flow upward through the tube and into the outer air. This upward draft operates to draw air into the arc-inclosing globe through an annular space which is purposely left

between the tube 45 and the walls of the arc-inclosing globe 40 as indicated.

What I claim as new and desire to secure by Letters Patent of the United States, is,

5 1. In an electric arc lamp, the combination of fume producing electrodes arranged vertically, one above the other, and means for directing a flow of air or gases laterally toward and vertically along the upper end  
10 of the arc, whereby the arc is steadied and insulating deposit upon the upper electrode is reduced and removed therefrom.

2. In an electric arc lamp, the combination of electrodes arranged vertically, one  
15 above the other, and a draft tube open at both ends directly surrounding the upper electrode and arranged with its lower open end substantially on a level with the lower end of the electrode.

20 3. In an electric arc lamp, the combination of electrodes arranged vertically, one above the other, with an arc-inclosing globe, the top cover for said globe having air ingress openings, and a draft tube open at  
25 both ends passing through the cover and directly surrounding the upper electrode and arranged with its lower end substantially on a level with the lower open end of the electrode, whereby the walls of the globe are  
30 swept by a down-draft and the upper electrode by an up-draft.

4. In an electric arc lamp, the combination of electrodes arranged vertically end-to-end, an arc-inclosing globe, a top cover  
35 for said globe having air ingress openings, and a draft directing chimney open at both ends and with its lower end substantially on a level with the lower end of the upper electrode within the globe and communicating  
40 with the external atmosphere.

5. The combination of electrodes arranged end-to-end, one above the other, an arc-inclosing globe, a conduit for producing a  
45 draft through said globe laterally toward and vertically along the upper end of the arc, and an intermediate purifying chamber in the draft conduit, whereby the arc is steadied, insulating deposit on the upper

electrode is reduced and solid products of combustion are held within the lamp. 50

6. The combination of electrodes arranged end-to-end, one above the other, an arc-inclosing globe, a conduit for producing a draft through said globe laterally toward  
55 and vertically along the upper end of the arc, an intermediate purifying chamber in the conduit, and depositing screens in said chamber.

7. In an arc lamp, a stationary lower electrode, a movable upper electrode, a  
60 holder therefor, a chimney member open at both ends secured to the electrode holder and terminating at its lower open end substantially on a level with the lower end of the upper electrode. 65

8. In an arc lamp, a movable upper electrode, and a draft tube or chimney comprising two sections, one of said sections being stationary and communicating with the external atmosphere, and the other section  
70 movable with the upper electrode and terminating at its lower open end substantially on a level with the lower end of the upper electrode.

9. In an arc lamp, a movable upper electrode, a holder therefor, and an open-ended sectional chimney member adjustably secured thereto. 75

10. In an arc lamp, a lower stationary electrode, an upper floating electrode, and a  
80 chimney member open at both ends secured to the floating electrode with its lower open end on substantially the same level as the lower end of the floating electrode.

11. In an arc lamp, a movable upper electrode, a holder therefor, and an open-ended  
85 sectional chimney member carried by the electrode holder and adjustable longitudinally with reference thereto.

In witness whereof, I have hereunto set  
90 my hand this 28th day of May, 1902.

JOHN T. H. DEMPSTER.

Witnesses:

BENJAMIN B. HULL,  
HELEN ORFORD.

A. BLONDEL.

ARC LAMP.

APPLICATION FILED JAN. 15, 1906.

992,479.

Patented May 16, 1911.

3 SHEETS—SHEET 1.

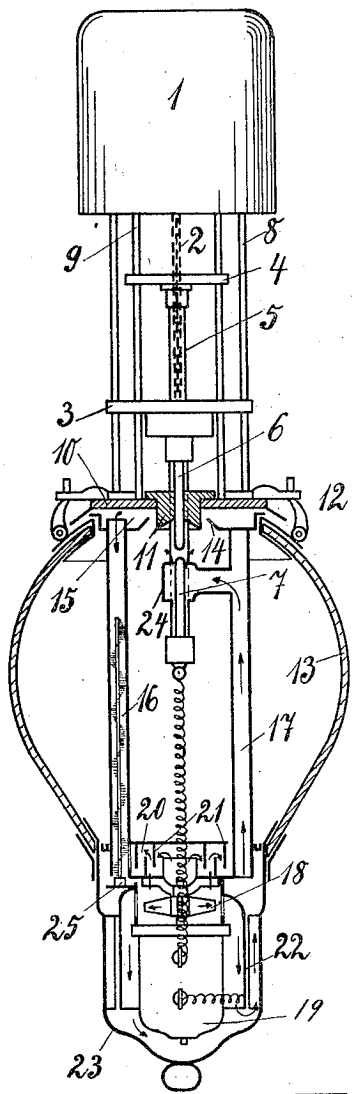


Fig. 1

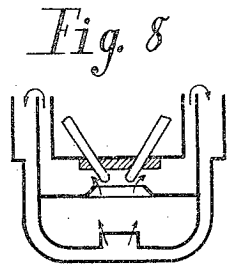


Fig. 8

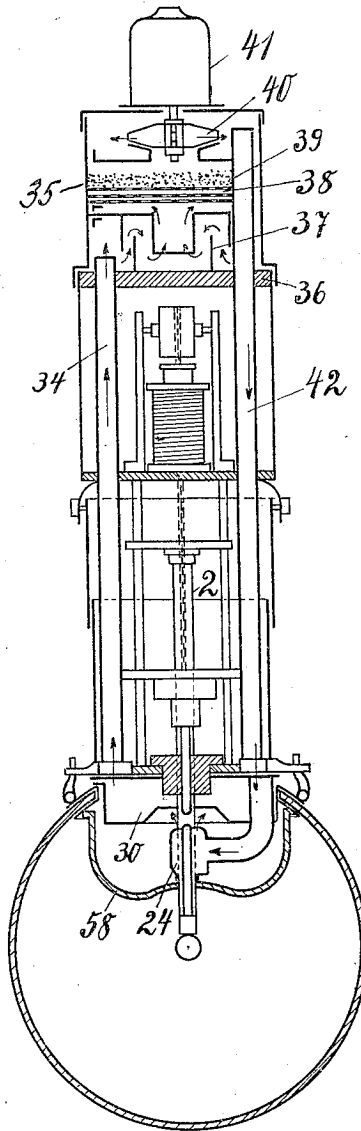


Fig. 3

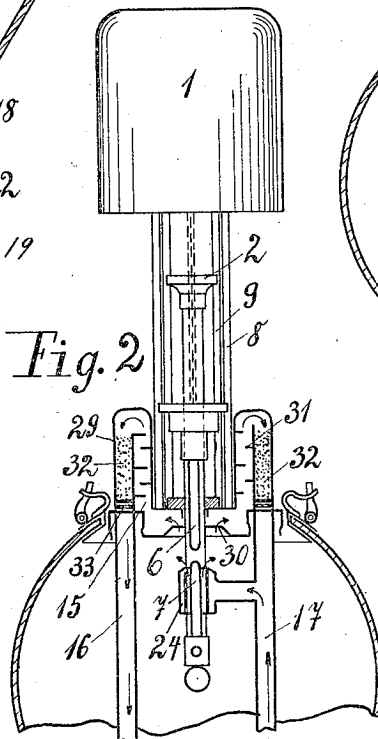


Fig. 2

Witnesses  
J. M. Dyer  
L. B. Hewitt

Inventor  
André Blondel,  
By *[Signature]*  
Attys

992,479.

Patented May 16, 1911.

3 SHEETS—SHEET 2.

Fig. 4

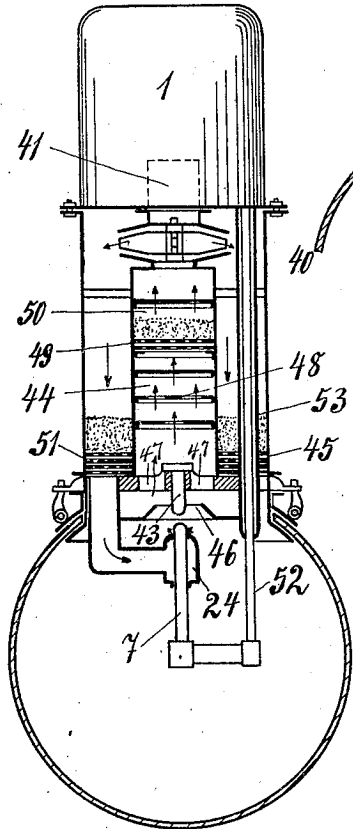


Fig. 6

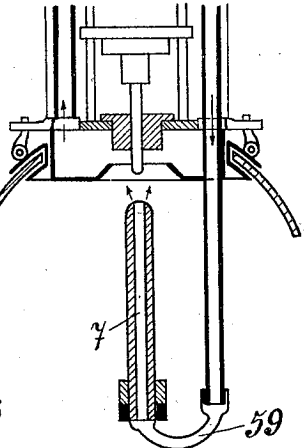


Fig. 5

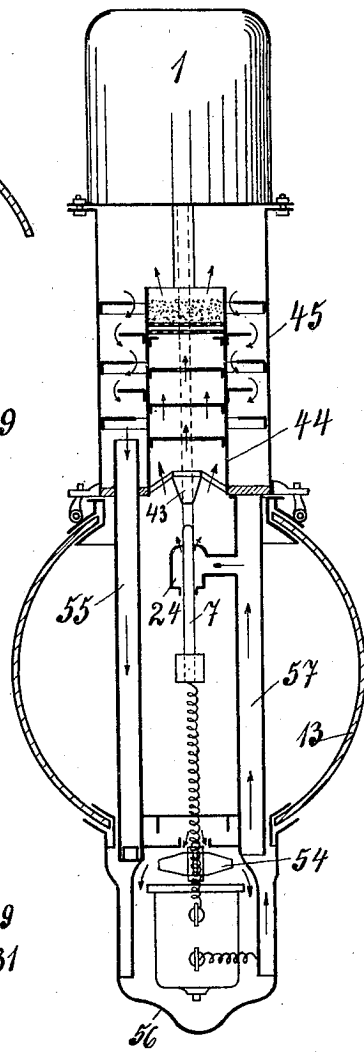
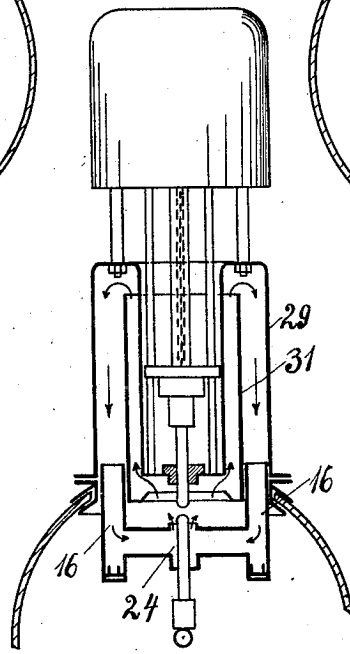


Fig. 7



Witnesses  
 J. M. Wynkoop  
 L. R. Nevitt

Inventor  
 Andre' Blondel.  
 By *Knight*  
 ATTYS

992,479.

Fig. 9.

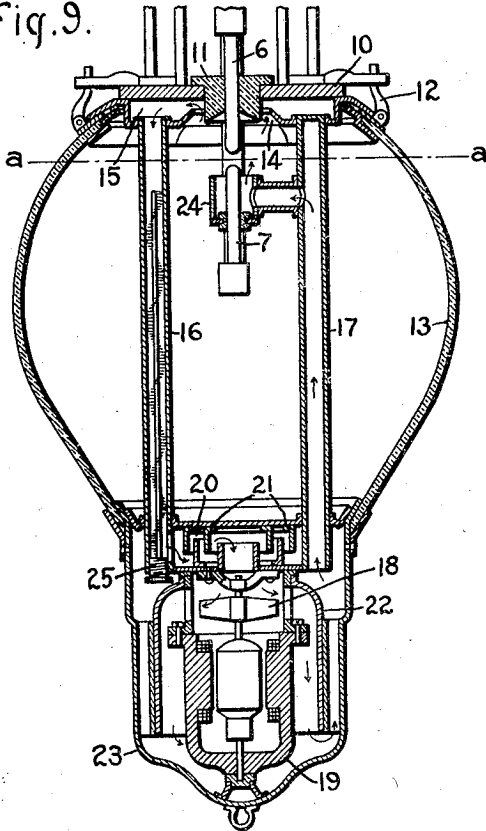


Fig. 10.

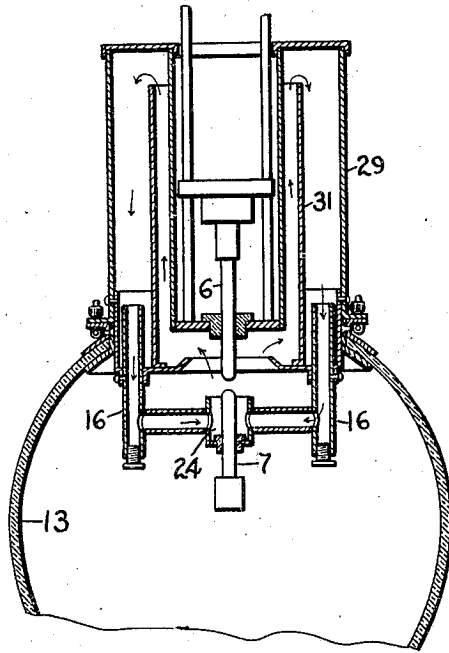


Fig. 11.

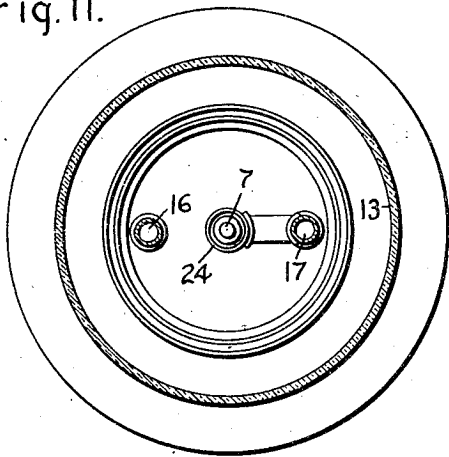
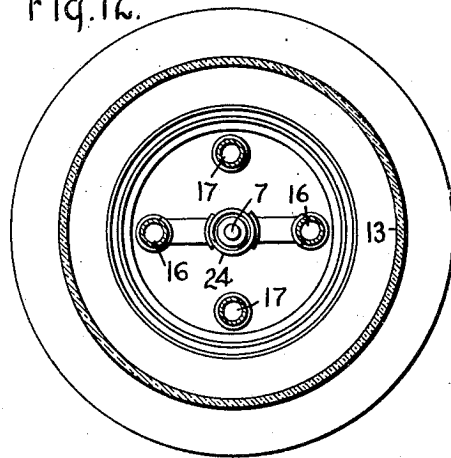


Fig. 12.



Witnesses:

Irving E. Steers.  
 J. Ellis Glen.

Inventor

Andre Blondel,  
 by *Robert G. Davis*  
 His Attorney.

# UNITED STATES PATENT OFFICE

ANDRÉ BLONDEL, OF PARIS, FRANCE, ASSIGNOR, BY MESNE ASSIGNMENTS, TO  
GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

992,479

Specification of Letters Patent. Patented May 16, 1911.

Application filed January 15, 1906. Serial No. 296,147.

*To all whom it may concern:*

Be it known that I, ANDRÉ BLONDEL, a citizen of the Republic of France, residing at 41 Avenue de la Bourdonnais, Paris, France, have invented a new and useful Improvement in Arc-Lamps, which improvement is fully set forth in the following specification.

Carbons or electrodes containing mineral substances are consumed less quickly in an arc lamp when a closed globe is employed, and as great advantages from the point of view of length of working are obtained as with ordinary carbons, but perfectly satisfactory results have hitherto not been obtained by reason of the lack of sufficiently good means for aspirating and condensing the fumes as they are produced and also because the path of the fumes in the globe has not been so limited as to prevent deposit upon the said globe.

In a lamp in which carbons impregnated with light giving salts are used, solid products of combustion are evolved from the arc usually in the form of rather copious white fumes, and attempts to inclose such an arc have usually resulted in the deposit of the fumes upon the globe, and this obstructed the light and seriously decreased the efficiency of the lamp.

My invention consists in providing in an inclosed lamp of this character a conduit for the gases evolved from the arc in which the gases are received at a point just above the arc and which returns them to the arc space at a point below the arc; and during this portion of their travel the gases are confined to the conduit and kept out of contact with the globe. For the purpose of creating and maintaining a circulation of the gases, I may either rely upon the natural draft produced in the circulatory system by the heat of the arc, or I may provide an artificial means for producing such a draft, the choice depending largely upon the character of the impregnated electrodes and of the circulatory system itself. Under certain conditions, it is desirable to place a filtering means within the circulatory system and under these conditions, particularly, I find it desirable to provide the artificial means for producing the draft. It is to be understood, however, that the essence of my in-

vention consists in providing a circulatory system for the gases, in which the gases are received and led from a point just above the arc to the space below the arc by a conduit or conduits distinct from the globe and in which deposit may take place.

In the drawings Figure 1 shows a partial vertical section, but rather diagrammatically, of a lamp embodying my invention; Figs. 2, 3, 4, 5 and 6 are like views of modifications of the structure shown in Fig. 1; Fig. 7 shows a like view of another modification in which the artificial means for producing a draft are dispensed with; Fig. 8 shows a diagram of my invention applied to an arc lamp in which converging electrodes are employed; Figs. 9 and 10 are vertical sectional views showing somewhat more in detail the arc lamp structures of Figs. 1 and 7 respectively; Fig. 11 is a horizontal sectional view taken through Fig. 9 on the line *a-a*, and Fig. 12 is a modification of the construction shown in Fig. 11.

Referring now to the drawings, Fig. 1 shows an arc lamp in which the mechanism is contained in a closed box 1, from which descend the chains or movable connections 2, which support the cross bars 3 of the upper carbon carrier and the cross bar 4 to which the rod 5 controlling the lower carbon carrier is fixed.

The upper and lower electrodes, of which at least one is mineralized, are indicated by reference numerals 6 and 7 respectively, while the rods for guiding the bars of the upper and lower carbon carriers are represented by the numerals 8 and 9. A cover closes the upper portion of the combustion chamber, the said cover being carried by fixed rods and provided, if desired, with an economizer 11, through the center of which the upper electrode passes.

To the cover 10 is fixed by means of suitable attachments 12 the globe 13 which forms an air tight joint with the cover 10.

Above and surrounding the arc is arranged a reflector 14 and an annular chamber 15 provided if necessary with suitable precipitating means such, for example, as the baffles and filters, indicated in Fig. 2, in order to cause the deposit of the densest fumes. From this chamber 15 starts a suitable number of tubes such as 16 (see Figs.

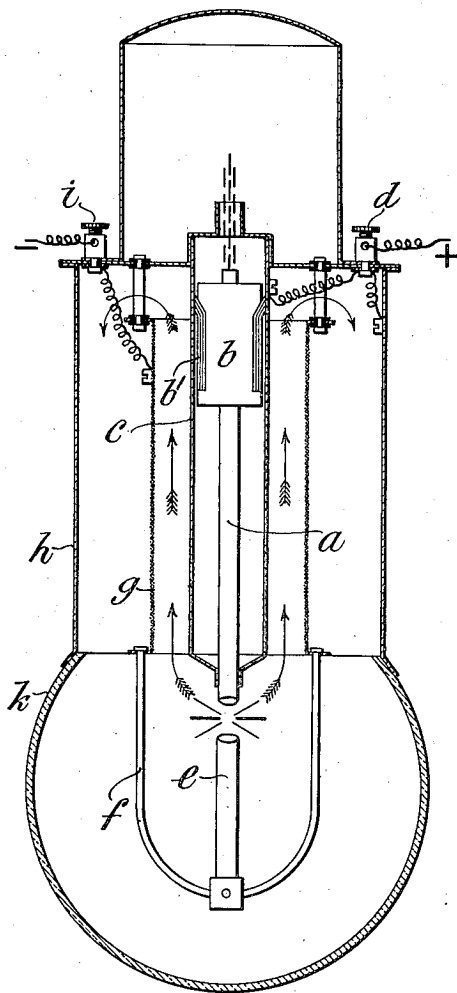
M. KÖRTING.

ARC LAMP.

APPLICATION FILED JAN. 26, 1911.

994,261.

Patented June 6, 1911.



Witnesses.

E. B. Franzoni.

M. E. Burrell

Inventor.

Max Körtling

By his Attorney

Frederic M. Light.



# UNITED STATES PATENT OFFICE.

MAX KÖRTING, OF LEUTZSCH, NEAR LEIPZIG, GERMANY, ASSIGNOR TO KÖRTING & MATHIESEN AKTIENGESSELLSCHAFT, OF LEUTZSCH, NEAR LEIPZIG, GERMANY.

## ARC-LAMP.

994,261.

Specification of Letters Patent.

Patented June 6, 1911.

Application filed January 26, 1911. Serial No. 604,845.

*To all whom it may concern:*

Be it known that I, MAX KÖRTING, a subject of the German Emperor, residing at 22 Bahnhofstrasse, Leutzsch, near Leipzig, Germany, have invented a new and useful Arc-Lamp, of which the following is a specification.

It is exceedingly difficult to prevent deposit on the globes of arc lamps especially when the electrodes contain materials adapted to cause deposit. This is prevented according to this invention by leading the gases produced by the arc past a surface or body or surfaces or bodies possessing electric potential. For example two metal cylinders insulated from each other may be employed, one cylinder being positively charged and the other negatively charged. The particles emanating from the electrodes may already possess a positive or negative charge and therefore attach themselves to the positive or negative surfaces. If the particles do not already possess a positive or negative charge, they receive a charge during their passage past the lower portion of the surface and therefore become attached to such surface at a later period. Any source of tension may be employed for the production of the continuous current pressure used to charge the surfaces or bodies and with continuous current arc lamps it may be the terminal pressure of the lamp. The arrangement of the surfaces or bodies and their shape and material will depend upon the special lamps for which they are intended, but preferably they are rough thus serving both to support the deposit mechanically and to facilitate the formation thereof electrically. Wire gauze is also suitable for the purpose.

The accompanying drawing illustrating the invention shows a continuous current arc lamp.

$a$  is an upper positive electrode,  $b$  the holder of the same.

$c$  is a metal tube or cylinder within which the holder  $b$  slides; the electrode  $a$  receives current from the metal tube  $c$  through

brushes  $b'$ , the tube  $c$  being connected with the positive terminal  $d$ .

$e$  is the negative electrode carried by a metal bracket  $f$  in electrical connection with a metal cylinder  $g$  which surrounds the cylinder  $c$ . The cylinder  $g$  is insulated in the lamp casing and is in electrical connection with the negative terminal  $i$ .

$h$  is the lamp casing and  $k$  the globe.

The two concentric metal cylinders  $c$  and  $g$  will be oppositely charged, the cylinder  $c$  positively and the cylinder  $g$  negatively. The lamp casing  $h$  may also if desired be connected with the positive terminal  $d$ . Gases charged with particles pass as shown by the arrow between the cylinders  $c$  and  $g$  and the particles according as they are positively or negatively charged deposit on the outer wall of the cylinder  $c$  or the inner wall of the cylinder  $g$ .

What I claim is:—

1. An arc lamp provided with a depositing surface supplied with electric potential.
2. An arc lamp provided with a plurality of depositing surfaces supplied with electric potential.
3. An arc lamp provided with a plurality of depositing surfaces, some supplied with a positive charge and some with a negative charge of electricity.
4. An arc lamp provided with a rough depositing surface supplied with electric potential.
5. A continuous current arc lamp provided with a plurality of depositing surfaces, one of which is connected with one terminal of the lamp and one with the other terminal thereof.
6. An arc lamp provided with a depositing surface supplied with electric potential past which gases charged with particles are caused to pass.

MAX KÖRTING.

Witnesses:

RUDOLPH FRICKE,  
ALBERT R. MORAWETZ.

A. BLONDEL.  
 INTERIOR ELECTRIC LIGHTING SYSTEM.  
 APPLICATION FILED SEPT. 27, 1911.

1,019,730.

Patented Mar. 5, 1912.

Fig. 2.

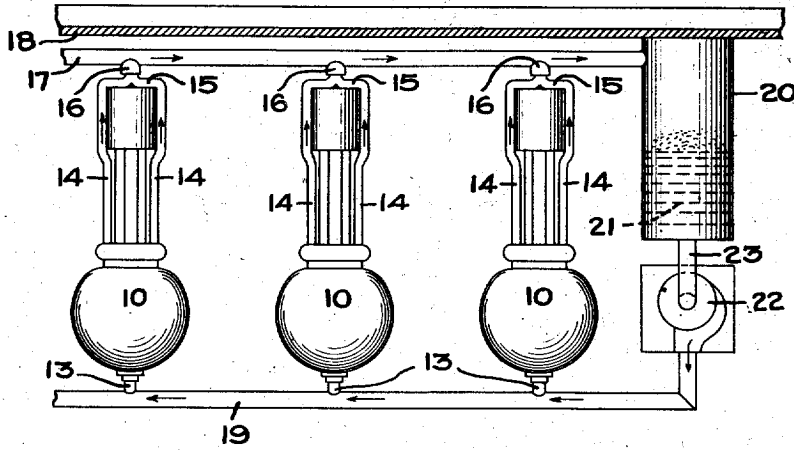
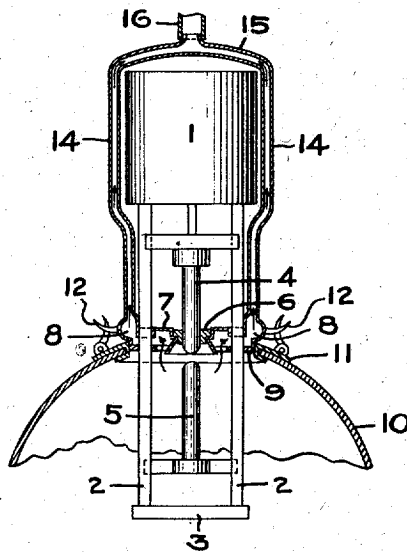


Fig. 1.



Witnesses:  
*Helen Orford*  
*J. Elbi Allen*

Inventor:  
*André Blondel,*  
 by *Albert G. Davis*  
 His Attorney.

# UNITED STATES PATENT OFFICE.

ANDRÉ BLONDEL, OF PARIS, FRANCE, ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## INTERIOR ELECTRIC-LIGHTING SYSTEM.

1,019,730.

Specification of Letters Patent.

Patented Mar. 5, 1912.

Original application filed September 9, 1904, Serial No. 223,899. Divided and this application filed September 27, 1911. Serial No. 651,491.

*To all whom it may concern:*

Be it known that I, ANDRÉ BLONDEL, a citizen of the Republic of France, residing at Paris, France, have invented certain new and useful Improvements in Interior Electric-Lighting Systems, of which the following is a specification.

My invention relates to improvements in interior electric lighting systems by flaming or luminous arc lamps, whereby such lamps are adapted for the lighting of rooms, halls, and other inclosed spaces, without subjecting the occupants of the room or other space to the inconvenience and danger of the poisonous products of combustion and without disfigurement or soiling of the walls of the room, or of the furniture, by the deposition thereon of the solidifiable products of combustion.

This application is a division of my application, serial No. 223,899, filed on Sept. 9, 1904.

In the accompanying drawing, which forms a part of this specification, Figure 1 is a vertical section through the casing and globe of an arc lamp adapted to my improved system, and Fig. 2 is an elevation of the system itself, the ceiling of the room or space in which it is installed being in section.

Like numerals indicate like parts in the drawing.

My invention provides means for carrying the products of combustion from all the lamps which are installed in a room, hall, or other space, either outside the room or to some definite place inside the room, to a depositing and purifying chamber common to all the lamps, and from there the air, cleaned of its noxious products of combustion, back through the lamps.

Referring to the drawing; a lamp adapted for use in my system is shown in outline. There is a housing 1 for the regulating mechanism, the tubes 2 2 descending from the same and connected at the lower ends by a cross piece 3, an upper electrode 4, and a lower electrode 5, both guided in their movements by the tubes 2 2; but the regu-

lating mechanism itself and the manner in which the same is connected with the electrodes is not here shown, since this forms no part of my invention, and any suitable regulating mechanism may be used. The upper electrode passes through an economizer 6, as is usual with flaming arc lamps, and this economizer is set in a diaphragm 7, which is secured to an annular chamber 8. A second diaphragm 9, parallel to and below the diaphragm 7, is secured to the lower edge of the annular chamber 8, and the guide tubes 2 2 pass through both diaphragms. The lower diaphragm 9 has a wide central opening through which the flaring funnel portion of the economizer projects, and this opening is wide enough to permit the products of combustion from the arc to freely ascend into the chamber 8. A glass globe 10 has its upper edge provided with a metal facing 11, which fits closely over the lower edge of the annular chamber 8, and the globe is held in place in that position by hooks 12, or other like devices, in such a manner that it may be removed when required for trimming the lamp, as is usual. The lower end of the globe is provided with a short tube or nipple 13, indicated in Fig. 2, whereby it may be connected with the canalization hereinafter described. From the annular chamber 8 extend upwardly, in free communication therewith, two or more tubes 14, which are joined to a cross tube 15 extending above the regulator housing of the lamp, and this cross connection is provided with a short tube or nipple 16, by means of which the lamp may be connected to the canalization as will presently appear.

The canalization is composed of two lines of pipe, one line 17 extending along the region of lamp distribution and near the ceiling 18 of the room or hall in which the lamps are installed, and the other line 19 also extends along the region of the lamp distribution close to the lower ends of the lamps. The nipples 13 are connected with this lower line of pipe 19, while the nipples 16 are connected with the upper line of pipe 17. Either within the room in which the

lamps are installed, at some suitable out-of-the-way place, or outside the room to be lighted, there is installed a purifying and depositing chamber 20, made of any good conductor of heat, such as metal, which in this instance is shown as secured to the ceiling, but which may be otherwise disposed. In this chamber there are filtering layers 21, suitably separated, and above these or between them, or both, are placed chemicals adapted to absorb or neutralize the non-solidifiable and poisonous products of combustion coming from the lamps. The filters and the whole body of the chamber operate to condense upon their surfaces the solidifiable products of combustion. Below this purifying and condensing chamber is installed a suitably driven air pump or fan 22, connected at one end to the bottom of the purifying and condensing chamber by a pipe 23 and at the other end to the lower line of pipe 19, as indicated. The upper line of pipe 17 is tapped into the upper part of the purifying and condensing chamber as shown.

Any number of lamps may be connected to the canalization in the manner indicated in Fig. 2, in which, by way of example, three such lamps are shown, and it is to be understood that beyond the last of these lamps the pipes 17 19 are closed in any desired manner and by any desired means.

In the operation of this system, the fan or pump 22 being set in operation and the lamps lighted the products of combustion emanating from the arc pass upwardly through the central opening in the diaphragm 9, into the annular chamber 8, and from there by pipes 14 and 15 and by the nipple or connection 16 into the upper line 17 of the canalization, and from there to and through the purifying and condensing chamber 20, where all the impurities of the products of combustion are absorbed or deposited, so that purified gas is now returned by the pipe 23 and pump or fan 22 to the lower line 19 of the canalization and by the nipples 13 back into the globes of the lamps. Arrows indicated in the drawing show the course of the circulation through the lamps and canalization.

It will be seen that with the system herein described any number of flaming or luminous arc lamps may be installed and operated in any inclosed space, such as rooms, halls, workshops, etc., without subjecting the persons in these spaces to the effect of the poisonous products of combustion and without soiling and disfiguring the walls of and the objects in the lighted spaces.

The size of the common purifying and condensing chamber should be made commensurate with the number of lamps in the

system, and the chemicals for absorbing or neutralizing the poisonous gases, and the filter plates, should be adapted to the particular kind of lamps for which the common purifying and condensing chamber is used. Lamps using one kind of electrodes will require different neutralizing chemicals and different grades of filters than lamps using other kinds of electrodes. I am, therefore, not limited to any particular filter or absorbing or neutralizing chemical. Again, if the electrodes used in the lamps yield no permanent injurious gases, but only solidifiable products, no chemical purifiers or neutralizers need be used and the chamber 20 becomes a simple depositing chamber.

It will be understood that the lamp structure may be changed in many ways without departing from my invention, so long as there is no opening left for the exit and inlet of gases except such as may be connected with a canalization in which a circulating air or gas current can be maintained which includes the lamp or lamps and a purifying or depositing chamber outside the lamp or lamps.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A system of electric interior lighting comprising a number of inclosed arc lamps, means for drawing the mixture of air and products of combustion simultaneously from all lamps, depriving the mixture of noxious matter at one point outside the lamps, and returning the purified air to the lamps.

2. An electric interior lighting system comprising conduits extending through the region of lamp distribution, one or more inclosed arc lamps connected to the conduits, means for creating a circulating air and gas current through these conduits and lamps, and means located outside the lamps for depriving the products of combustion of the lamps of noxious matter.

3. In an interior electric lighting system the combination of one or more inclosed arc lamps, each provided with a definite air inlet and a definite outlet for the products of combustion, with a system of conduits extending through the region of lamp distribution, the lamp inlets and outlets being connected to said conduits, means for producing a circulation of the air and gas through the conduits and a purifying and condensing chamber included in said circulation.

4. In an electric interior lighting system the combination of one or more inclosed arc lamps, each provided with a definite air inlet and a definite outlet for the products of combustion, with a conduit extending near the tops of the lamps throughout the region of lamp distribution and to which the lamp

outlets are connected, another conduit extending near the bottoms of the lamps throughout the region of lamp distribution connected with the lamp inlets, and means  
5 for drawing the products of combustion from the lamps into the first conduit, depositing the solidifiable products at one point outside the lamps and returning the

purified air through the second conduit and to the lamps.

In witness whereof, I have hereunto set my hand this 8th day of September, 1911.

ANDRÉ BLONDEL.

Witnesses:

MARIA CORNET,  
HANSON C. COXE.

H. BECK.  
 ELECTRIC ARC LAMP FOR SEARCH LIGHTS, PROJECTORS, AND  
 APPLICATION FILED DEC. 12, 1911.

1,029,787.

Patented June 18, 1912.

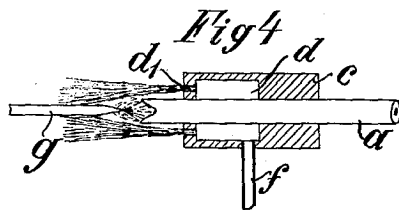
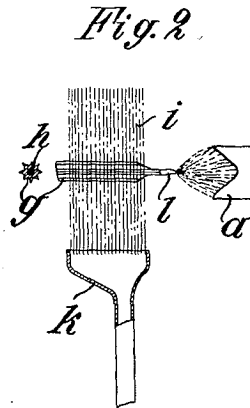
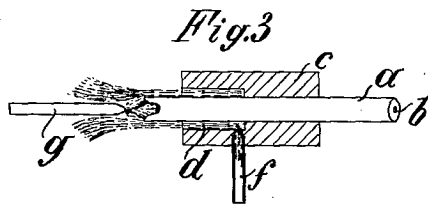
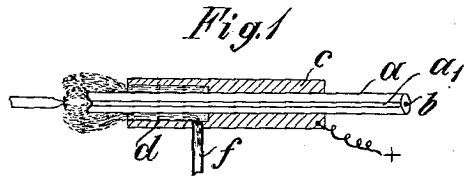
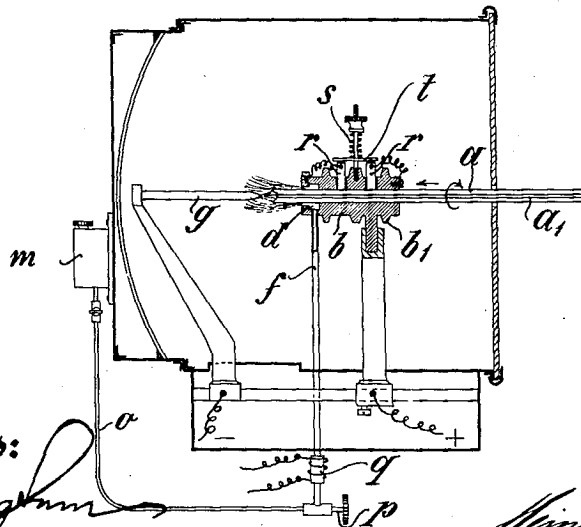


Fig. 5



Witnesses:  
*M. Cunningham*  
*J. Stone*

Inventor:  
*Hiram Beck*

# UNITED STATES PATENT OFFICE.

HEINRICH BECK, OF MEININGEN, GERMANY.

ELECTRIC-ARC LAMP FOR SEARCH-LIGHTS, PROJECTORS, AND THE LIKE.

1,029,787.

Specification of Letters Patent. Patented June 18, 1912.

Application filed December 12, 1911. Serial No. 665,328.

To all whom it may concern:

Be it known that I, HEINRICH BECK, a subject of the German Emperor, and residing at Meiningen, Germany, have invented certain new and useful Improvements in Electric-Arc Lamps for Search-Lights, Projectors, and the Like, of which the following is a specification.

My invention relates to methods of working electric arc-lamps and to arrangements of electrodes for search-lights, projectors and the like.

A primary object of my invention is to improve the output of light of electric arc-lamps for search-lights, projectors and the like by forming an intensely luminous positive crater which is as small as possible. To this end, I employ electrodes containing light-emitting admixtures, *e. g.* metallic salts or carbids either in the form of a core or as admixtures with the carbon, or in the form of a metallic core of the positive electrode, and I make the diameter at the tip of the positive electrode of this kind very small as compared with the diameter of electrodes heretofore customary for like strengths of current.

For example, by employing suitable means described hereinafter, the diameter at the tip of the positive electrode can be smaller than that which is normal for the largest section of the luminous crater at the tip for a predetermined strength of current when carbons without light-emitting admixtures are employed and when these means are not employed. Thin electrodes thus highly loaded with light-emitting admixtures or provided with metallic cores are protected in a suitable manner by an envelop or jacket of indifferent or reducing gases or vapors from being overheated and prematurely destroyed. In the case of thin, highly loaded carbons, and particularly, when the strength of current is great, the gaseous jacket fulfils another special purpose. In these thin electrodes traversed by heavy currents the current has a great tendency at the tip of the positive carbon to go over to the shell outside the crater, so that the current does not issue, as desired, only at the end of the carbon. Now when such highly loaded, thin electrodes are supplied in the hereinafter described manner with a jet of vapor or gas, I have found that the arc is completely displaced from the outer portion of the carbon. Consequently, the current issues only at the end of the carbon,

whereby a considerable concentration on the crater of the electrode results. The temperature at the end of the carbon is exceedingly increased, the crater prevented from spreading laterally bores its way into the carbon provided with light-emitting admixtures, and the vapors filling the crater in combination with the remainder of the white-hot carbon vapor result in a very greatly increased emission of light. The increase in the specific luminosity of the crater calculated from the diameter of the greatest cross-section of the crater as compared with ordinary carbon craters amounts in the new arrangement to 300% and may possibly be increased still more.

When a gaseous or vaporous jacket is employed around the positive carbon provided with light-emitting admixtures or with a metallic core considerably thinner carbon rods can be employed than normally corresponds with the diameter of the crater of carbons customary heretofore in search-lights. According to Nerz the normal diameters of customary carbons is for:

20 amperes	9 mm.	80 amperes	15.3 mm.
40 "	10 mm.	100 "	18 mm.
60 "	12.1 mm.	120 "	20 mm.
70 "	13.5 mm.	150 "	23 mm., etc.

Now if, for example, according to the above table, the crater of a 120 ampere lamp were 20 mm. in diameter in the customary arrangement and employing customary carbons, according to my new arrangement such a lamp can be worked with carbons 13 mm. in diameter. The crater cannot be larger than 13 mm. in diameter. Owing to this diminution in diameter of the crater the so-called strengthening capacity of the reflector of the search-light is increased which behaves as  $D^2:d^2$ , when  $D$  designates the diameter of the reflector and  $d$  the diameter of the crater. The gaseous or vaporous envelop or jacket may be produced either directly in the lamp, or a suitable current of gas or vapor may be supplied to the electrode. Coal-gas, carbonic acid gas, nitrogen, hydrogen, acetylene as well as vapors of benzine, ether, alcohol and the like may, for example, be employed. The causes of the action of such a gaseous or vaporous jacket, particularly the causes of the arc being limited to the end of the carbon are as yet not completely explained theoretically. It is probable that the current of gas or vapor cools the carbon shell and conse-

quently renders difficult the issue of the current through the shell or impedes the vaporization of the carbon at this place. Chemical changes under the action of the gaseous or vaporous jacket may also cooperate, because, for example, at the parts of the shell of the carbon around which the current of vapor or gas flows the surface is coated with a layer of graphite when gases or vapors containing carbon, *e. g.* hydrocarbons, are used. Also, mechanical influences of the flowing current of gas may play a part. It is probable that all the mentioned influences and perhaps others which are unknown when operating together bring about the total effect.

The gaseous or vaporous jacket may be supplied to the carbon through a suitably connected nozzle. A vaporous or gaseous jacket can also be formed by liquids, which can be gasified or vaporized, or solid substances being converted near the electrode into the form of vapor or gas and by the jet of vapor or gas thus formed being conducted onto the positive electrode. Further, for producing the vapor or gas the heat of the arc can be utilized. The vaporable substances can also be preliminarily heated or vaporized by means of a separate source of heat, *e. g.* an electrical resistance.

The carbons may be provided with ribs or grooves, *e. g.* be made of stellar section, whereby, on the one hand, the cooling surface for the vaporous or gaseous jacket is increased and, on the other hand, when the diameter of the carbon at the rear end is large the diameter of the crater end of the carbon can be diminished corresponding to the height of the ribs which burn away more readily.

It has been found preferable for obtaining steady burning slowly to rotate the positive carbon while it burns, in order to remove the deposit of soot produced on the carbon when combustible gases are employed.

The combustible vapors or gases constituting the jacket which surrounds the carbon and is finally burned can be neglected as regards their luminosity in comparison with the quantity of light emitted by the crater.

As negative electrode either an ordinary carbon can be employed or, however, a carbon of specially small diameter surrounded, like the positive electrode, with a gaseous jacket. This is of special importance for obtaining a positive crater which burns as quietly as possible when working search-lights with heavy currents and highly loaded, thin positive electrodes. When heavy currents are employed the negative electrodes of small diameter burn away relatively rapidly, because the negative electrode generally has a greater length made

red-hot. When gases or vapors which impede the rapid combustion of the thin negative carbon are also supplied according to my invention to the burning end of the thin negative electrode, a gaseous jacket or envelop very poor in oxygen is formed around the negative carbon. As the gases or vapors employed in this case are partially good conductors of heat, owing to the supply of gas or vapor to the negative electrode this electrode is also cooled in a desirable manner and the consumption and heating of the negative carbon are impeded still further. In view of the high current density of the thin negative electrode I preferably employ a carbon having a metallic coating which can be made electrolytically, or a carbon having a metallic core. The surface of the negative carbon may be artificially increased by ribs or grooves in order that the cooling action of the gases may have as large a surface as possible on which to act, and also in order that as slender a tip as possible may be formed on the negative electrode. It has also proved particularly suitable to provide the negative electrode with a core of a material more refractory than that of which the shell of the carbon is composed. A vaporous or gaseous jacket can be formed at the negative electrode as in the case of the positive electrode by converting liquids or solid substances near the negative electrodes or by means of a separate source of heat into the form of vapor or gas and conducting the jet of vapor or gas thus formed to the negative electrode.

The feed mechanism of the lamp is preferably so constructed that the negative carbon is fed more rapidly than the positive, *e. g.* at twice the speed.

Some illustrative embodiments of my invention and arrangements of electrodes suitable for carrying my method into practice are represented diagrammatically by way of example in the accompanying drawing, wherein:—

Figure 1 shows one arrangement of electrodes, a positive electrode being surrounded by a gaseous jacket, and Fig. 2 shows another arrangement of electrodes, the negative electrode being located in a stream of gas; Figs. 3 and 4 show modifications of the arrangement shown in Fig. 1, and Fig. 5 diagrammatically represents the general arrangement in a search-light.

Referring firstly to Fig. 1, an arrangement of the electrodes according to my invention is here shown, in which only the positive electrode *a* is surrounded by a gaseous jacket, said electrode having one or more longitudinally-extending cooling ribs *a'*. In this illustrative embodiment the positive carbon *a* which is provided with a core *b* of light-emitting substances is guided in a metallic tube *c* to which the electric current can



be directly supplied. This tube has near the burning end a cylindrical cavity *d* into which projects a gas nozzle *f* through which is supplied the current of gas for forming around the electrode a gaseous jacket. This jacket is ignited when the gas supplied is a combustible one, *e. g.* coal-gas.

In the embodiment shown in Fig. 2 the negative electrode *g* of stellar cross-section, as shown, as directed upon it a current of gas *i* issuing from a nozzle *k* of suitable shape. The electrodes *g* may have a core *h* of any suitable material that is more refractory than the carbon shell around the core.

A point *l* is formed at the tip of the negative electrode *g*. When a combustible gas *e. g.* coal-gas, is employed, the gas will ignite and surround the electrode *g* in the form of a flame.

Fig. 3 shows an arrangement of electrodes similar to that in Fig. 1, but the negative electrode *g* is also surrounded by the jet of gas or vapor which issues from the positive electrode *a* and in this case is preferably supplied at a higher pressure to the nozzle *f* than is the gas supplied to the nozzle of Fig. 1.

Fig. 4 shows another modification of the arrangement according to Fig. 1 in which the metallic tube *c* surrounding the positive carbon has in it a cylindrical chamber *d* which opens toward the end of the positive electrode through a number of fine nozzle-like holes *d*<sub>1</sub>.

Fig. 5 shows in section in a search-light one form of the general arrangement when liquids are employed for forming a vaporous jacket. The positive electrode *a* has one or more longitudinal ribs *a'* and is led into a thick metallic tube *b* which may be provided with cooling ribs *b*<sub>1</sub>. The current of vapor is supplied to the chamber *d* in the tube *b* through the pipe or nozzle *f* which is fed by way of the tube *o* from the receptacle *m* attached to the rear wall of the search-light. The supply of the liquid can be regulated by a screw *p* and it is vaporized either by the heat which is generated in the casing of the search-light, or its vaporization can be brought about or aided by a special heating device outside the search-light casing, *e. g.*, as indicated, by an electrical resistance *q*. In the illustrative embodiment the current is supplied to the positive electrode by means of contact pins *r* which are arranged in the tube *b* and are pressed by a plate *t* under the pressure of a coil spring *s*. The positive carbon *a* is led outward preferably through the front part of the search-light, *e. g.* the glass and the screen, and rotated for preventing the deposit of soot and for obtaining uniform burning. When gas is supplied directly, the gas tube will be directly connected to the pipe or nozzle *f*.

The above-described arrangements accord-

ing to my invention may be modified in very various ways as will be readily understood from the foregoing.

I claim:—

1. The herein described method of working electric arc-lamps for search-lights or projectors comprising a positive and a negative electrode, the positive electrode containing light-emitting admixtures of metal, metallic salts or carbids, which consists in subjecting the positive electrode to the influence of a jet of an indifferent gas or vapor during the working of the lamp, for the purpose specified.

2. The herein described method of working electric arc-lamps for search-lights or projectors comprising a positive and a negative electrode, the positive electrode containing light-emitting admixtures of metal, metallic salts or carbids, which consists in subjecting both the electrodes to the influence of a jet of an indifferent vapor or gas, for the purpose specified.

3. In an electric arc-lamp, the combination of a positive electrode, a negative electrode, the positive electrode containing light-emitting admixtures of metal, metallic salts or carbids, and having a diameter smaller than the diameter of the crater for the same current in an arc-lamp comprising a positive electrode without a light-emitting admixture, means for concentrating the current density at the end of the crater of the positive electrode and for limiting the oxidation of the remainder of the end of the positive electrode, and means for supplying an electric current to the electrodes, substantially as described, for the purpose specified.

4. In an electric arc-lamp, the combination of a positive electrode, a negative electrode, the positive electrode containing light-emitting admixtures of metal, metallic salts or carbids, and having a diameter smaller than the diameter of the crater for the same current in an arc-lamp comprising a positive electrode without a light-emitting admixture, a nozzle near the tip of the positive electrode for supplying a jet of an indifferent gas or vapor to the positive electrode, and means for supplying an electric current to the electrodes, substantially as described, for the purpose specified.

5. In an electric arc-lamp, the combination of a positive electrode, a negative electrode, the positive electrode containing light-emitting admixtures of metal, metallic salts or carbids, a metallic tube surrounding the positive electrode for supplying an electric current thereto, said tube having a cavity at the front end thereof, a nozzle opening into said cavity for supplying an indifferent gas or vapor to the positive electrodes, substantially as described, for the purpose specified.

130

6. In an electric arc-lamp, the combination of a positive electrode, a thin, negative electrode, the positive electrodes containing light-emitting admixtures of metal, metallic salts or carbids, means for surrounding the tip of the positive and of the negative electrode with a jacket envelop of an indifferent gas or vapor during the working of the lamp, and means for supplying an electric

current to the electrodes, substantially as described, for the purpose specified.

The foregoing specification signed at Coburg, Germany, this 29th day of November, 1911.

HEINRICH BECK.

In presence of two witnesses:

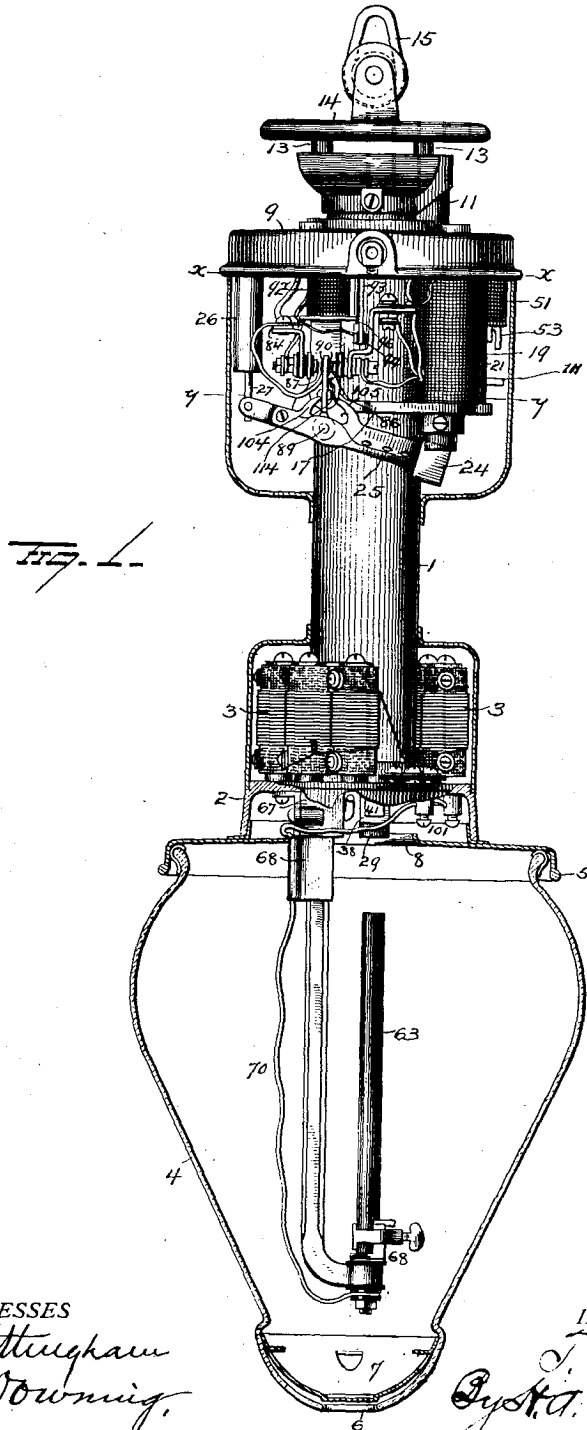
M. C. DILLINGHAM,  
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ELECTRIC ARC LAMP.  
APPLICATION FILED JULY 8, 1909.

1,058,514.

Patented Apr. 8, 1913.

8 SHEETS—SHEET 1.



WITNESSES  
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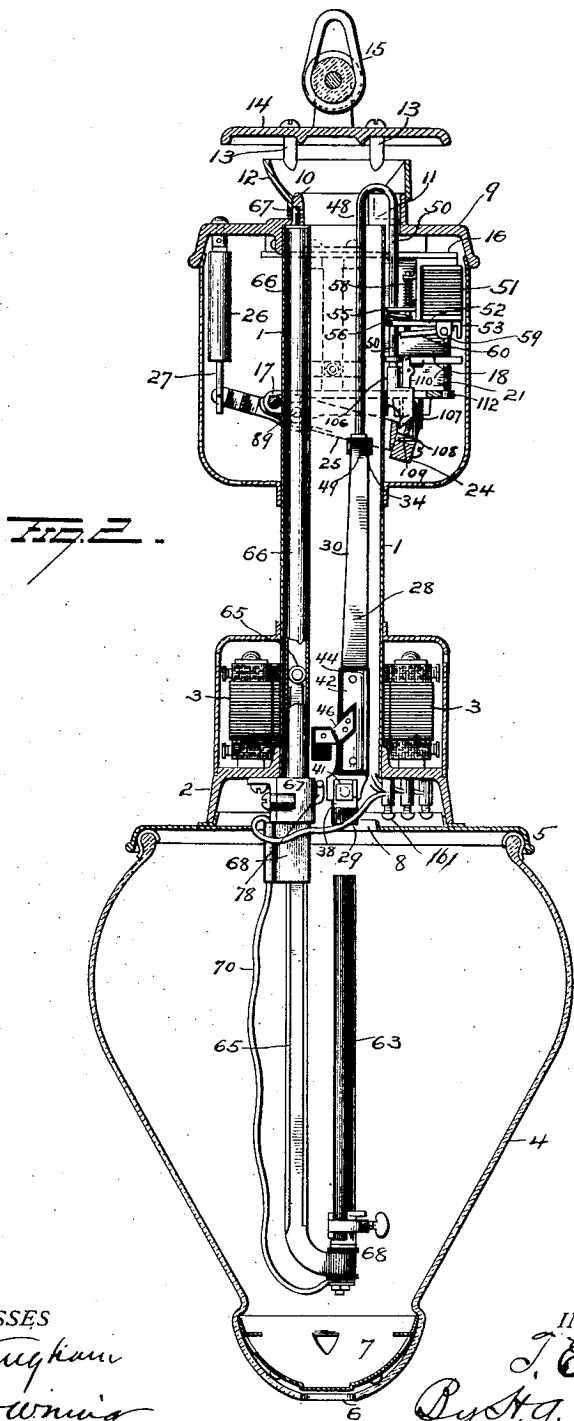
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8 SHEETS—SHEET 3.

Fig. 3.

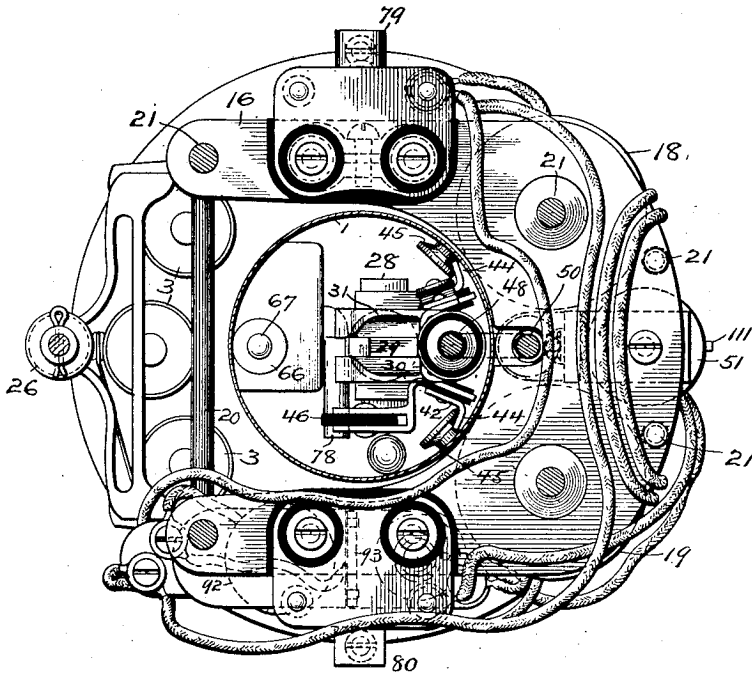
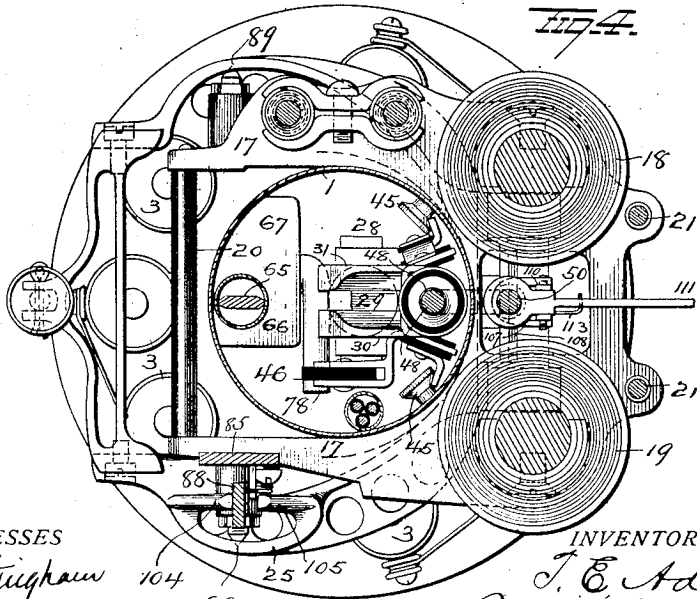


Fig. 4.



WITNESSES  
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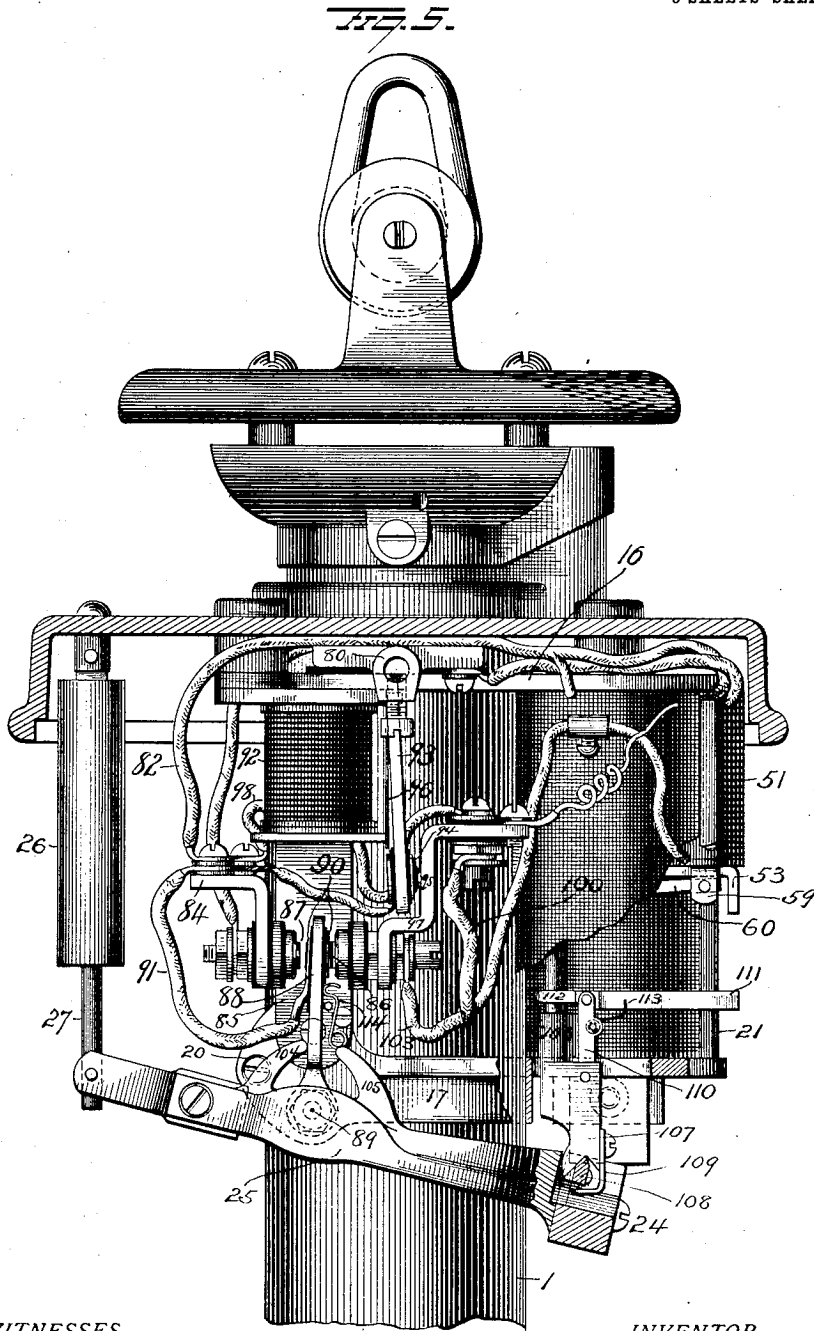
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8 SHEETS—SHEET 4.



WITNESSES  
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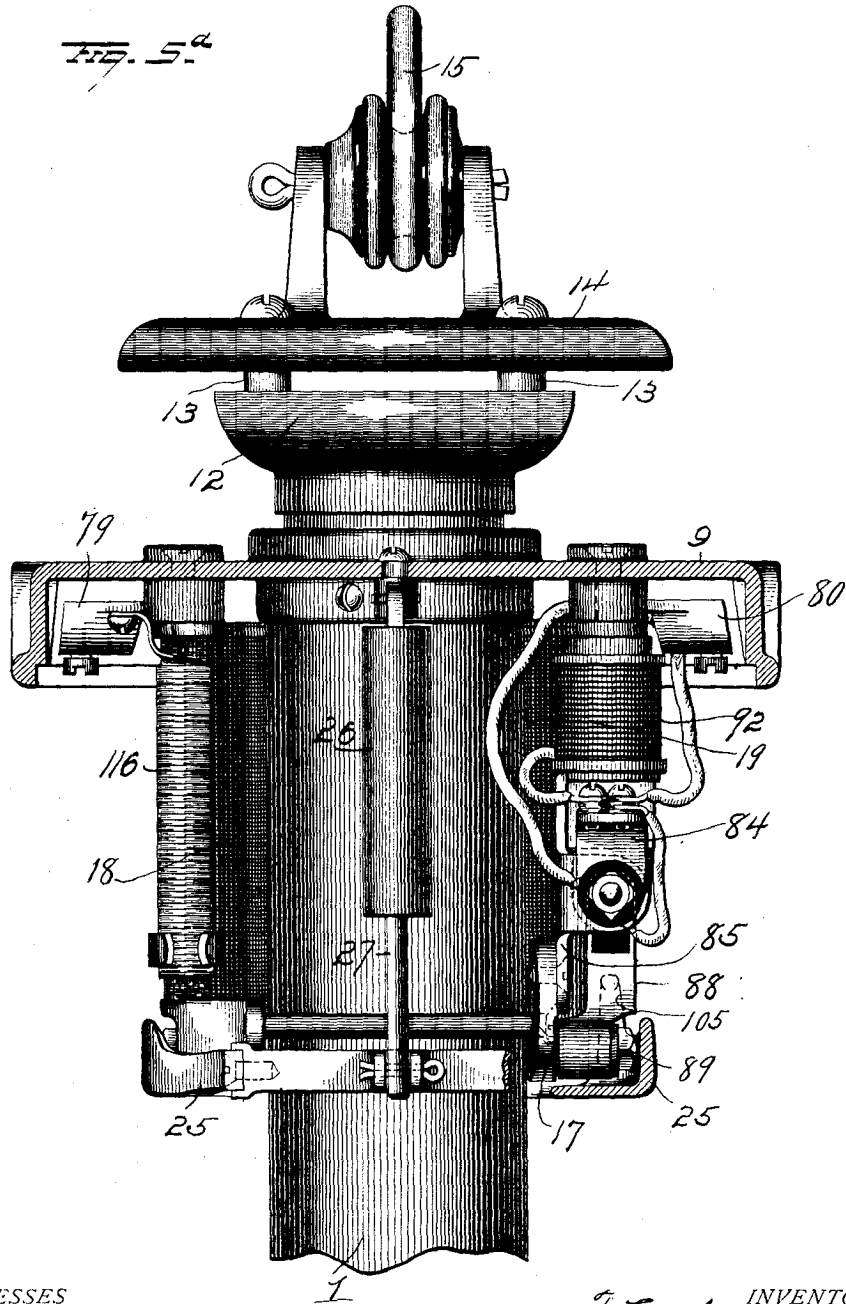
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8 SHEETS—SHEET 5.



WITNESSES  
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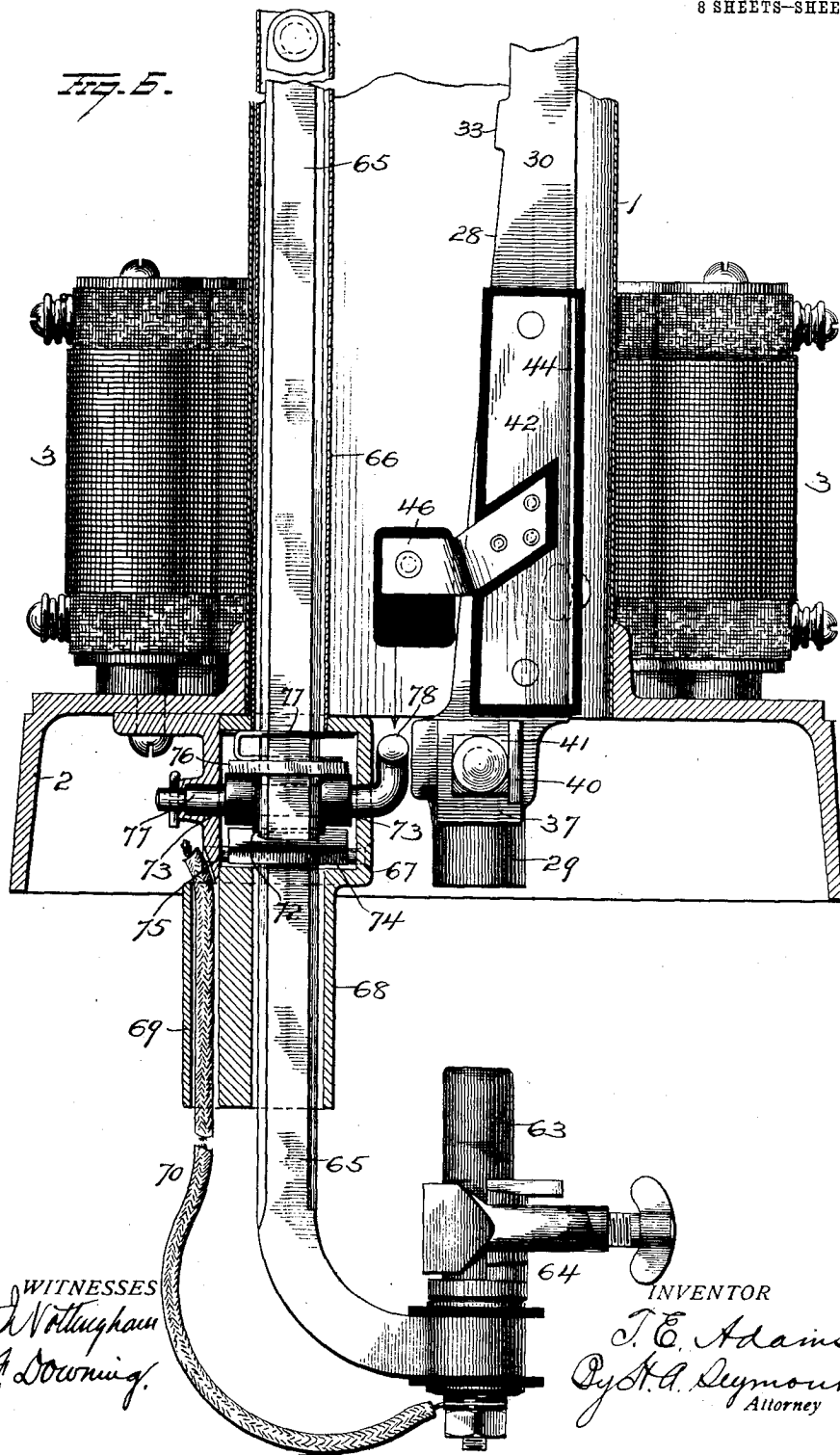
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8 SHEETS—SHEET 6.



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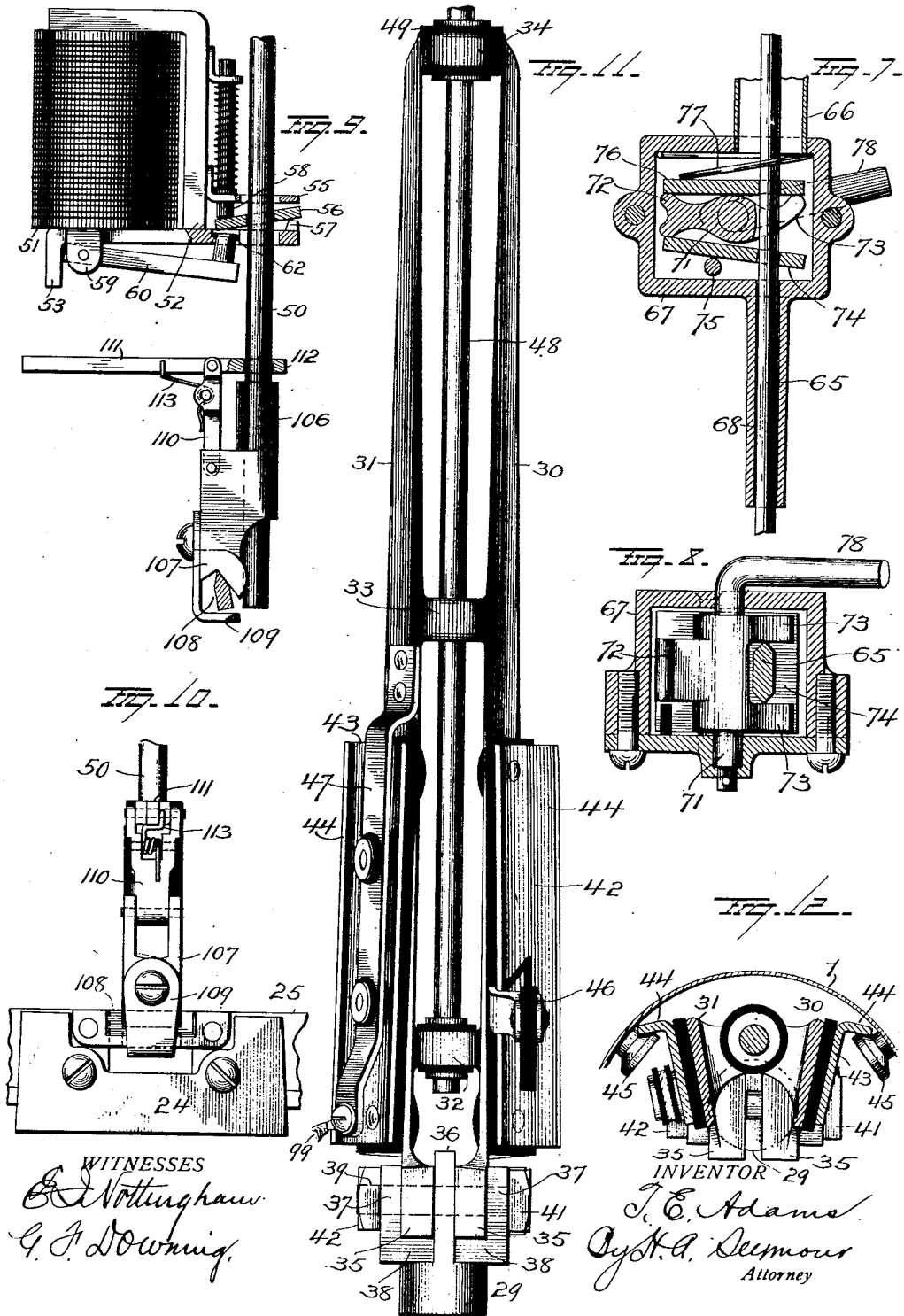


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Patented Apr. 8, 1913.

8 SHEETS—SHEET 7.



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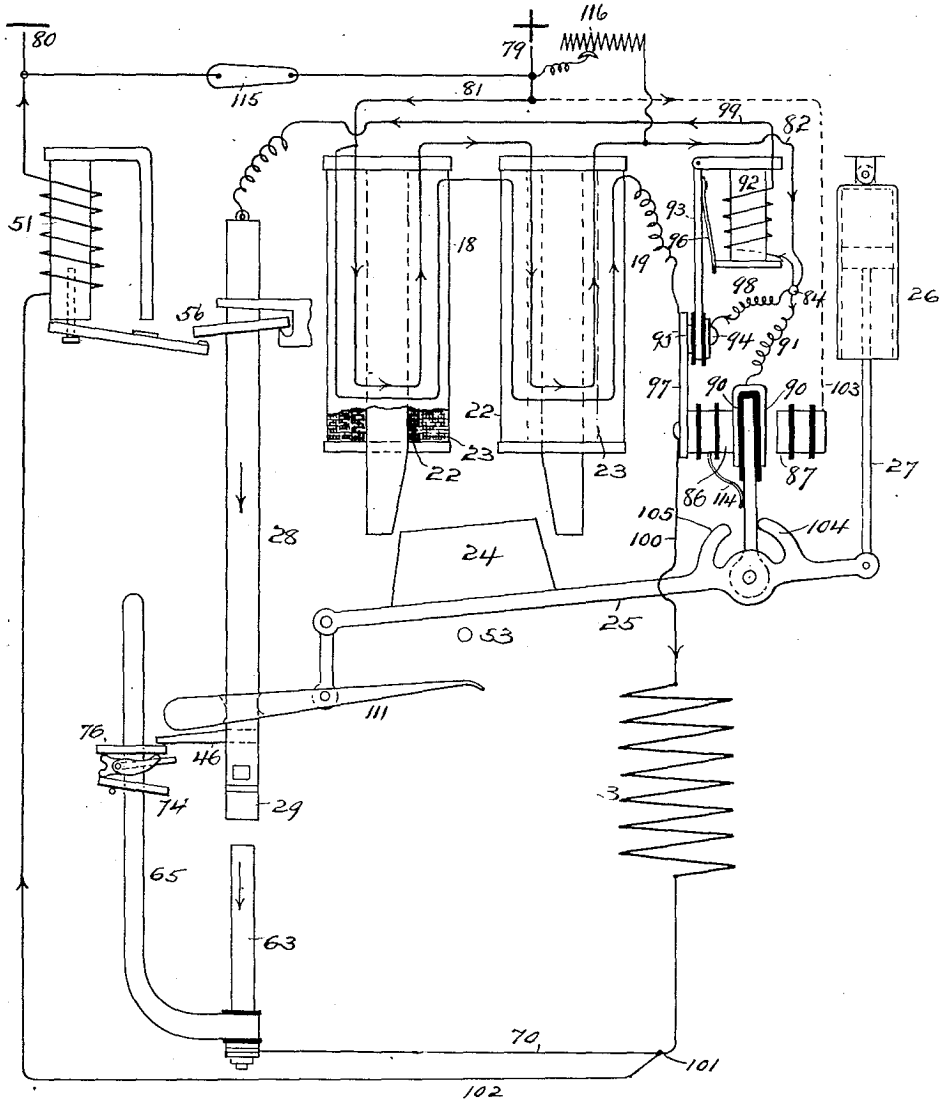
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8 SHEETS—SHEET 8.



~~Fig. 5.~~

WITNESSES  
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# UNITED STATES PATENT OFFICE.

THOMAS EDGAR ADAMS, OF CLEVELAND, OHIO, ASSIGNOR TO THE ADAMS-BAGNALL ELECTRIC COMPANY, OF CLEVELAND, OHIO.

ELECTRIC-ARC LAMP.

1,058,514.

Specification of Letters Patent.

Patented Apr. 8, 1913.

Application filed July 8, 1909. Serial No. 506,587.

*To all whom it may concern:*

Be it known that I, THOMAS E. ADAMS, 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.

This invention relates to improvements in electric arc lamps and more particularly to such as are adapted for use with metallic electrodes, the object of the invention being to construct the operating mechanism in such manner that it will operate to free the electrodes of insulating scoriaceous deposits and thus permit the lamp to properly start.

A further object is to provide regulating and controlling mechanism for an arc lamp which will operate to bring the metallic electrodes into forcible engagement and to repeat such action until the scoriaceous deposits shall be sufficiently removed from the ends of the electrodes to permit proper electrical contact of the latter with each other.

A further object is to provide an arc lamp in which the arc shall be established by the manipulation of the upper electrode, and in which the upward feeding of the lower electrode to maintain the arc shall be controlled directly by the movements of the holder of the upper electrode.

A further object is to provide an arc lamp in which the upward feeding of the lower electrode to maintain the arc shall be effected mechanically by the movement of the upper electrode.

A further object is to provide means which shall be operated to mechanically raise the lower electrode, and to so construct and arrange such mechanical means that it shall be rendered active to raise the lower electrode by means movable with the upper electrode.

A further object is to construct an arc lamp with mechanical operating means for positively engaging the lower electrode carrier to raise said electrode and to provide the carrier of the upper electrode with means for positively actuating said mechanical operating means.

A further object is to provide an arc lamp

in which electrical means are provided for controlling the upper electrode in establishing and regulating the arc and in which the lower electrode is fed upwardly by mechanical means actuated by means movable with the upper electrode.

With these and other objects in view, the invention consists in certain novel features of construction and combinations of parts as hereinafter set forth and pointed out in the claims.

In the accompanying drawings; Figure 1 is an elevation partly in section of the lamp; Fig. 2 is a vertical sectional view; Fig. 3 is a horizontal section on the line  $x-x$  of Fig. 1. Fig. 4 is a sectional view on the line  $y-y$  of Fig. 1; Fig. 5 is an enlarged detail view of the regulator mechanism; Fig. 5<sup>a</sup> is an elevation at right angles to Fig. 5 looking from left to right of the latter; Fig. 6 is an enlarged sectional view showing the lower portion of the lamp; Figs. 7 and 8 are enlarged sectional views of the devices which control the operation of the lower electrode; Fig. 9 is a detail view showing the clutches for the upper electrode carrier; Fig. 10 is a detail view showing the connection of the clutch arm 111 with the armature yoke 25; Fig. 11 is an enlarged view of the upper electrode carrier; Fig. 12 is a detail view showing the guide devices for the upper electrode carrier, and Fig. 13 is a diagrammatical view.

1 represents a tube which may constitute a portion of the lamp casing and inclose a portion of the mechanism of the lamp. To the lower end of this tube, an annular casting 2 is secured and supports a series of resistance coils 3 which are utilized in the operation of the lamp as hereinafter described. The casting 2 also supports a cover-reflector for a globe 4, suitable means being provided for removably holding the latter in place with its upper edge disposed within the depending peripheral flange 5 of the cover. In the present instance, the globe is provided in its bottom with an opening 6 for the admission of air, and this opening is covered by means of a pan 7 supported in the bottom of the globe to receive slag from the lower metallic electrode. The pan 7 is provided on its bottom with projections 7<sup>a</sup> to prevent the same from closely fitting the

bottom of the spherical portion 7<sup>b</sup> of the globe and closing the opening therein, and to further guard against too greatly restricting the passage of air into and through the globe, the pan 7 is provided with openings 7<sup>c</sup> which are overhung by lips 7<sup>a</sup> to prevent the escape of slag through said openings. The globe cover is made with a central opening 8 disposed in line with the lower end of the tube 1 and permits the escape of fumes from the arc upwardly through said tube.

A hood 9, which may consist of a casting of iron or other suitable metal is secured to the upper end of the tube 1 and is provided centrally with an opening surrounded by an annular flange 10 having a laterally projecting portion 11 for a purpose which will hereinafter appear. A cap 12, which may be conveniently made of brass, is secured to the annular flange 10 and provided with a series of posts 13 to which a top plate 14 is secured. A suitable device 15 is attached to the top plate 14, by means of which the lamp may be suspended from a suitable support. With the arrangement of parts above described, it is apparent that air entering the globe will pass upwardly through the tubular casing 1, carrying with it, fumes from the arc, (which latter, as will be hereinafter pointed out, is located in proximity to the opening in the center of the globe cover), such fumes escaping to the outer air through the spaces formed by the posts 13 under the top plate 14.

A plate or frame 16 is supported by the hood 9, and between this plate and a yoke 17 two magnets 18—19 are supported, the yoke 17 being made to partially embrace the tube 1 and having its ends connected and braced by means of a rod 20. The yoke 17 is also secured to the poles of the magnets and connected with the supporting plate 16 under the hood 9 by means of rods 21. The magnets 18—19 are provided with coarse wire coils 22 included in the working circuit of the lamp and with fine wire coils 23 included in a shunt circuit so as to form parts of an electrically differential regulator mechanism. The armature 24 for the magnets 18—19 is carried by a yoke 25 pivotally supported by the fixed yoke 17 and embracing the tube 1. For the purpose of steadying the movements of the armature yoke, an air pot 26 is provided and suspended from the hood 9, the rod 27 carrying the plunger for this air pot, being connected to the armature yoke at the end thereof opposite the armature.

The carrier 28 for the upper metallic electrode 29 is located in the tube 1 and comprises two elongated members 30—31 spaced apart and rigidly connected together by cross bars 32, 33—34. The members 30—31 of the upper electrode holder are provided

at their lower ends with jaws 35 between which the slotted shank 36 of the upper electrode 29 is disposed. Blocks 37 placed against the jaws 35 are provided with lips 38 disposed between the lower ends of the jaws and the body of the electrode, and through the blocks 36, the jaws 35 and the slotted shank of the electrode, a clamping bolt 39 is passed. One end of this bolt is provided with a head 41 to engage a lug 40 on one of the blocks 36 and the other end of said bolt is threaded for the reception of a nut 42. Plates 43 are secured to but insulated from the respective members 30—31 of the electrode carrier, and provided with flanges 44 which cooperate with buttons or projections 45 on the inner face of the tube 1, to guide the electrode carrier in its vertical movements and maintain it at all times in proper alinement with the lower electrode. The member 30 of the carrier 28 also carries a fixed arm 46 having a head of insulating material for a purpose hereinafter explained. An arm or plate 47 is secured to the member 31 of the carrier 28 and electrically connected therewith, said arm serving as means for connecting the upper electrode in the lamp circuit. A rod 48, having its lower portion disposed between the members 30—31 of the carrier 28, is secured at its lower end to but insulated from the lower cross bar 32 of said carrier 28 and passes through an insulated bushing 49 in the upper cross bar 34 at the upper end of the carrier. The rod 48 extends upwardly from the carrier 29 and its upper portion is bent to form a downwardly projecting arm 50 which passes within the lateral portion 11 of the flange 10 on the head 9 and then through a hole in the latter,—the free end of said arm 50 terminating outside the tube 1 and between the magnets 18—19.

Secured to and depending from the plate or frame 16 and disposed between the magnets 18—19, is a small magnet 51, to the lower end of which, an arm or plate 52 (preferably of non-magnetic material) is secured and provided with a hole in which the pole of the magnet is located. The arm or plate 52 is provided at one end with a depending lug 53 and near its other end (which projects laterally from the frame of magnet 51) a hole 54 is provided for the passage of the depending arm 50 of the rod 48. An arm 55 projects laterally from the frame of magnet 51 so as to be disposed a short distance above the arm or plate 52 and this arm 55 is made with a hole which alines with the hole in the arm 52 for the passage of the arm 50 of rod 48. Between the arms 52 and 55, a ring clutch 56 encircles the arm 50 of rod 48 and normally rests near its edge upon a lug 57 projecting upwardly from the arm 52. A spring actuated pin 58 carried by the frame of magnet 51 presses upon the

ring clutch at a point diametrically opposite the engagement of the latter with the lug 57 so as to assure the proper engagement of said clutch with the arm 50 of rod 48 to hold the same against the weight of the parts which it carries and maintain the upper electrode elevated and out of contact with the lower electrode when the lamp is not in circuit. The plate 52 is provided at or near one end with lugs 59 between which an armature 60 for the magnet 51 is pivotally supported. This armature carries, at its free end, a pin 62 which passes through the arm or plate 52 adjacent to the hole 54 in the latter, and engages the ring clutch 56 at a point directly below the engagement of the spring-pressed pin 58 with the latter. The pin 62 is provided with a head to limit the downward movement of the armature. The electrically controlled clutch devices above described are especially valuable for sustaining the upper electrode and holding it out of contact with the lower electrode, upon the extinguishment of the lamp, so as to prevent the welding of the electrodes together while they are hot, which is liable to occur when metallic electrodes (such as employed in flaming arc lamps) are permitted to remain in contact after the arc has been extinguished.

During the normal operation of the lamp, the electrically controlled clutch devices will be maintained inactive by the operation of the magnet 51, which is included permanently during such period, in the working lamp circuit.

The upper electrode will be made of material which offers comparatively low electrical resistance, preferably an alloy of copper and tin, and the lower electrode 63 will be of ferro-titanium or similar material suitable for use in a lamp of the flaming arc type.

The lower electrode 63 is maintained in a holder 64 at the lower end of a blade or carrier 65. For the accommodation of this blade, a tube 66 is located within the tube 1 of the casing and at its upper end the tube 66 is provided with a head having a pin 67 which enters a socket in the cap 12. The lower end of the tube 66 is secured to and communicates with a housing 67 secured to the bottom annular casting 2 of the lamp frame, and this housing is provided with a depending hollow arm 68 for the passage of the blade 65. The arm 68 is also made with a tubular portion 69 for the passage of a conductor 70, by means of which the lower electrode 63 is included in the lamp circuit. An oscillatory spindle 71 is mounted in the housing 67 and provided at one side with an arm 72 and at the other side with fingers 73, the latter straddling the blade 65 which passes through the housing at one side of the spindle 71 therein. Below the spindle

71, a clutch plate 74 is located and provided at one side of its center with a slot for the passage of the blade 65, said plate being adapted to rest at the other side of its center upon a pin or support 75 within the housing 67, said clutch plate thus acting normally to prevent descent of the blade 65 and the lower electrode carried thereby. Another clutch plate 76 is disposed within the housing 67 and provided at one side of its center with a slot for the passage of the blade or arm 65 and against this clutch plate at the opposite side of its center, a spring 77 bears. This spring serves to maintain the upper clutch plate 76 normally horizontal with its respective ends resting upon the arm 72 and fingers 73 of the spindle 71,—in which position of the clutch plate 76, the arm of blade 65 carrying the lower electrode, can have free movement, such movement in a downward direction being prevented however, by the action of the lower clutch plate 74. The spindle 71 is provided at one end with a crank arm 78 located exteriorly of the housing 67 and in the path of the arm 46 on the upper electrode carrier.

With clutch devices such as above described, for the lower electrode carrier, when crank arm 78 of the spindle 71 is depressed, said spindle will be partially rotated, causing its arm 72 to raise one end of the clutch plate 76 against the resistance of the spring 77. The plate 76 will immediately clutch the blade or arm 65 and as the crank arm 78 continues its downward movement and the spindle continues to turn, the arm 72 of the spindle will raise said plate 76 bodily and thus elevate the blade 65 and the lower electrode carried thereby. When the spindle is thus operated, the fingers 73 will press upon the lower clutch plate 74 and depress the end thereof through which the blade 65 passes, (the tendency of said plate 74 being to rise when the blade 65 is raised) so that said clutch plate 74 will be in position to immediately grip the blade when the spindle 71 and the upper clutch plate 76 are permitted to be moved to their normal positions by the action of the spring 77.

Normally, when the lamp is not in circuit, the electrodes will be separated, and the controlling mechanism is so constructed and arranged both electrically and mechanically that when current first enters the lamp, the upper electrode will be raised and then immediately dropped. When the upper electrode thus falls, the insulated head on the arm 46 projecting from the carrier 28 will engage the crank arm 78 of the spindle 71 and the clutch devices within the housing 67 will be operated as above described to raise the lower electrode a short distance. The mechanism will continue to raise the upper electrode and permit it to drop until the upper electrode strikes the lower electrode

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and if the accumulation of scoriaceous material on the electrodes is such as will electrically insulate one from the other, the upper electrode will continue to reciprocate, and continuously striking upon the lower electrode after the manner of the operation of a trip hammer, will effectually remove scoriaceous matter from the lower electrode and jar insulating deposits from the lower end of the upper electrode until current will be permitted to pass from one electrode to the other, after the lower electrode has been raised sufficiently to meet the upper electrode when the latter drops, the subsequent downward or dropping movements of said upper electrode will be limited and the arm 46 on the carrier 28 will be prevented from fully depressing the crank arm 78 of the spindle 71 of the clutch devices for the lower electrode and hence, after the electrodes have come together, the upward feeding operation of said clutch devices will be stopped during the hammering of the upper upon the lower electrode. As soon as sufficient current is permitted to pass from one electrode to the other, an arc will be drawn between them and regulated until a finger 104 moves a switch arm 88 far enough to start the upper electrode pounding to raise the lower electrode. This occurs before the arm 46 rests on the crank arm 78. This establishing, regulating and feeding continues until the electrodes have been consumed, when this has occurred, the lamp may be automatically cut out by the engagement of a part carried by the negative electrode carrier with a part connected with the plus terminal of the lamp.

To accomplish the operations above described, the mechanism now to be described is employed: The plus and minus terminals of the lamp mechanism are indicated at 79 and 80 respectively. The terminal binding post 79 is connected by a suitable conductor 81 with one terminal of the coarse wire windings of the regulator magnets and the other terminal of said coarse wire windings is electrically connected, by means of a conductor 82 with an arm or binding post 84 sustained by but insulated from a bracket 85 supported by the fixed yoke 17. Two contacts 86—87 are supported by the bracket 85 and upon the shank of one of these contacts, the arm or binding post 84 is supported but insulated therefrom. The upper end of a switch arm 88 is disposed between the contacts 86 and 87 and the lower end of this arm is mounted upon a pin 89 projecting from the fixed yoke 17,—said switch arm having sufficient frictional engagement with the pin causes it to remain in the position between the contacts 86—87 to which it may be moved as presently explained. The switch arm 88 is provided near its upper end with electrically connected con-

tacts 90 to cooperate with one or the other of the fixed contacts 86 or 87, and the contacts 90 are connected, by means of a conductor 91, with the arm or binding post 84. A small electro-magnet 92 is disposed over the bracket 85 and with this magnet, a pendulous armature 93 cooperates. This armature depends below the magnet 92 and is provided with a contact 94 which is insulated therefrom and is normally pressed (when the magnet 92 is not energized) against a contact 95, by means of a spring 96. The contact 95 is carried by a conductor bar or bracket 99 which serves to electrically connect it with the contact 86. The contact 94 is electrically connected with the arm or binding post 84 by means of a conductor 98, and said arm or binding post is also electrically connected with one terminal of the coil of magnet 92. The other end of the coil of this magnet is connected by means of a conductor 99 with the arm 47 of the upper electrode carrier 28. The conductor bar or bracket 97 is connected by a wire 100 with one terminal of the cut-out resistance 3, and the other terminal of this resistance is connected with a binding post 101 and the latter is connected by means of the conductor 70 with the lower electrode holder. The binding post 101 is also connected by means of a conductor 102 with one terminal of the coil of the clutch magnet 51, the other end of said coil being electrically connected with the minus terminal binding post, 80. The contact 87 is connected, by means of a conductor 103 with the plus terminal binding post 79 of the lamp, so that when the switch lever 88 is moved to cause its contact 90 to engage the contact 87, the regulator magnets 18—19 will be short circuited. One terminal of the fine wire windings of the regulator magnets is connected with the plus terminal 79 of the lamp and the other end of said fine wire winding is connected with the conductor bar or bracket 97, which latter is connected with the minus terminal of the lamp as before explained, so that the fine wire windings will be in a constantly closed circuit shunting the arc. The pivoted yoke 25 which carries the armature 24 for the regulator magnets is provided with two fingers 104—105, the former of which engages the switch lever 88 to maintain the engagement of the contacts 90—86 when the armature 24 and its yoke 25 are in their lowest positions and the regulator magnets 18—19 are not energized. A spring 114 bearing against the switch lever 88 will operate to move said lever and separate one of the contacts 90 from the contact 86 when the finger 104 moves away from said switch lever.

It has been hereinbefore explained that the arm 50 which depends from the upper

end of the rod 48 secured to the upper electrode carrier 28, passes through the electrically controlled clutch 56, by the action of which latter the upper electrode is held elevated above the lower electrode when the lamp is out of circuit. After passing through the clutch 56, the depending arm 50 enters a guide tube 106, and the latter is provided at its lower end with an enlargement 107 which is loosely mounted upon a knife-edge bearing plate 108 secured to the pivoted yoke 25 in proximity to the armature 24. Displacement of the tubular guide 106 from the bearing plate 108, is prevented by means of a bent arm 109 secured to the enlargement 107 and projecting under said bearing plate. The enlargement 107 of the guide tube 106 is provided with lugs between which one end of an arm 110 is pivoted and to the other end of this arm, a clutch lever 111 is pivotally attached. One end of the clutch lever is made with a clutch ring 112, disposed over the top of the guide tube 106 to permit the passage of the arm 50 of rod 48, through it, and said clutch ring is caused to normally grip said arm 50, by the action of a spring 113. Thus it will be seen that the yoke 25 and its armature 24 are connected with the arm 50 of rod 48 by means of the clutch devices above described, so that when the armature rises, the upper electrode will be raised until the clutch lever 111 engages the depending lug 53, when the clutch lever will be tripped and the upper electrode carrier permitted to drop.

When the manually operated cut-out switch 115 (shown only in the diagram, Fig. 13) is opened, the current will pass through the coarse wire coils of the regulator magnets 18-19 and then by conductor 82 to the arm or binding post 84. The current will then pass to the conductor bar 97 through the conductors 91-98 and contacts 94-95 and 90-86. The current will then pass through the resistance 3 and then by the conductor 102 to and through the coil of magnet 51 and finally to the negative terminal 80 of the lamp. The controller magnets 18-19 will now be energized to raise the armature 24 and its yoke 25, and at the same time, the magnet 51 will be energized to lift the clutch 56 and release it from gripping contact with the arm 50 connected with the upper electrode carrier, but the clutch 112 carried by the armature yoke 25 will immediately grip said arm 50 and as said yoke is moved upwardly by the action of the regulator magnets, the upper electrode will be raised. As soon as the armature yoke begins to rise, the finger 104 will move away from the switch lever 88, and the spring 114 will promptly move said switch lever so as to electrically separate one of its contacts 90 from the contact 86, thus

opening one of the parallel circuits between the arm or binding post 84 and the conductor bar 97. The armature yoke 25 and upper electrode will continue to rise until the lever 111 of clutch 112 engages the lug or stop 53, when the clutch 112 will be tripped and the upper electrode carrier released, permitting the upper electrode to be dropped upon the lower electrode. The weight of the electrode carrier 28 and rod 48, added to that of the upper electrode, will cause the latter to strike the lower electrode with sufficient force to dislodge more or less of the insulating, scoriaceous deposits which may be adhering to said electrodes. When the upper electrode has been tripped and permitted to drop, as above described, the continued upward movement of the armature yoke 25 will cause its finger 105 to engage the switch lever 88 and move the same so as to bring one of its contacts 90 into engagement with the contact 87. The circuit including the conductor 103 will now be closed and the regulator magnets 18-19 short-circuited. The armature 24 and yoke 25 will now descend, causing the finger 104 to engage the switch lever 88 and shift the same so as to open the short circuit and close the circuit between the arm or binding post 84 and the contact 86 on the bar 97. Assuming that the insulating scoriaceous material on the electrodes was sufficient to prevent the passage of current from the upper to the lower electrode, when the upper electrode was dropped as above described, the same operations of raising the upper electrode and dropping it upon the lower electrode will be repeated, and these trip hammer actions of the upper upon the lower electrode will continue until the insulating deposits on the electrodes shall have been sufficiently removed to render the contacting ends of the electrodes conductive and thus permit the passage of current from one to the other. Current will now be permitted to traverse the circuit including the coil of magnet 92 and the coarse coils of the regulator magnets in series with each other and the magnet 92 will thus be energized to move its armature 93 and open the contacts 94-95. At the same time, the armature 24 will be drawn up by the regulator magnets 18-19 and the upper electrode will be separated from the lower to establish the arc between them,—the cut-out circuit including the resistance 3 being opened as soon as the armature 24 begins to rise, by the separation of the contacts 90-86. The coils of magnets 51 and 92 being in the main circuit during the normal operation of the lamp, these magnets will remain energized,—the former to maintain the clutch 56 in released position, and the latter to maintain the circuit of the resistance 3 open. The arc will be maintained at the proper

voltage by the movements of the armature 24 as controlled by the electrical differential between the coarse wire main coils and the fine wire shunt coils of the regulator magnet.

5 The strength of the main current in the coarse wire coils of the regulator magnets may be varied by means of an adjustable resistance 116 located in a circuit shunting said coils. The upward feeding of the lower electrode as the latter becomes consumed, is effected by the engagement of the arm 46 on the upper electrode carrier, with the crank arm 78 on spindle 71 to operate the clutch devices in the housing 67 and raise the blade 65 and the lower electrode carried thereby, as previously explained. Should the lower electrode be a considerable distance below the upper electrode when current first enters the lamp, the clutch devices in the housing 67 will be operated to raise the lower electrode step by step until it is in position to be struck by the reciprocating upper electrode, the reciprocations of the upper electrode then continuing until the ends of the electrodes are rendered conductive by the absence of scoriaceous material,—all as hereinbefore explained. The regulator mechanism outside of the tubular portion 1 of the lamp frame, may be protected by means of a suitable shell or cover 117, and the resistance coils 3 may be protected by a cover 118.

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

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

1. In an electric arc lamp, the combination with metallic electrodes, of a clutch for the upper electrode, means for raising and lowering said clutch continuously while no current is passing through the electrodes, and means for tripping the clutch each time it is thus raised, whereby the upper electrode will be a number of times successively dropped upon the lower electrode.

2. In an electric arc lamp, the combination with metallic electrodes, of a clutch for the upper electrode, electrically controlled means for reciprocating said clutch continuously while the electrodes are out of circuit, and means for tripping said clutch each time the same is raised to release the upper electrode and drop the same upon the lower electrode.

3. In an electric arc lamp, the combination with metallic electrodes, of a clutch for the upper electrode, electrically controlled means for raising and lowering said clutch and tripping the same while the electrodes

are not in circuit to drop the upper electrode, and means tending to feed the lower electrode upwardly when the upper electrode drops.

4. In an electric arc lamp, the combination with metallic electrodes, of a clutch for the upper electrode, means for raising and lowering said clutch continuously for starting the lamp, means for tripping the clutch each time it is thus raised, whereby the upper electrode will be a number of times successively dropped upon the lower electrode, and devices movable with the upper electrode and serving to increase the weight thereof to increase the force of the blow of said upper electrode upon the lower electrode.

5. In an electric arc lamp, the combination with metallic electrodes, of a magnet, an armature therefor, a clutch connected with the armature and vertically movable bodily therewith, means for tripping the clutch to release the upper electrode when in a raised position, and means for short circuiting said magnet after the clutch has been tripped and for opening the short circuit after the armature shall have been released.

6. In an electric arc lamp, the combination with metallic electrodes and a clutch for the upper electrode, of a magnet, a pivoted lever, an armature carried by the latter, means connecting the armature lever to said clutch for raising the latter and the upper electrode, means for tripping the clutch when the same has been raised by the armature lever to release the upper electrode and to permit it to fall freely, and switch devices controlled by the movements of the armature lever to short circuit said magnet after the clutch has been tripped and to open the short circuit after the armature shall have been released.

7. In an electric arc lamp, the combination with metallic electrodes, of a magnet, a pivoted lever, an armature for the magnet carried by said lever, a clutch for the upper electrode connected with said lever and movable vertically therewith to raise the upper electrode, a circuit shunting said magnet, a switch included in said circuit, means for tripping said clutch when the latter is in raised position to release the upper electrode and to permit it to fall freely, and means controlled by the armature lever for closing and then opening said switch after the clutch has been tripped, during the upward and downward movements respectively of said lever.

8. In an electric arc lamp, the combination with a vertically movable upper electrode carrier, and a vertically movable lower electrode carrier, of a clutch engaging the lower electrode carrier, operating means engaging said clutch for raising the same and the lower electrode carrier, and means movable with the upper electrode carrier and in

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position to engage the operating means of said clutch to raise the latter and the lower electrode carrier when said upper electrode carrier descends.

5 9. In an electric arc lamp, the combination with a frame and a housing carried thereby, of a lower electrode carrier passing through said housing, a clutch plate located within said housing and engaging the lower  
10 electrode carrier, a spindle mounted in said housing and having an arm to engage said clutch plate, a crank arm on said spindle exteriorly of the housing, an upper electrode carrier, and an arm on the upper electrode  
15 carrier to engage said crank arm and actuate the spindle and clutch plate to raise the lower electrode carrier.

10. In an electric arc lamp, the combination with a frame and a housing supported  
20 by the lower portion thereof, of a spindle mounted in said housing, clutch plates disposed above and below the spindle, a support in the housing for one of said clutch plates, projections on respective sides of the spindle  
25 between the clutch plates, a spring bearing against the upper clutch plate, a lower

electrode carrier passing through the housing and the two clutch plates therein, a crank arm on said spindle, an upper electrode carrier, and an arm on said upper electrode carrier for engaging said crank arm to operate the spindle and the upper clutch plate to positively raise the lower electrode holder.

11. An electric arc lamp comprising metallic electrodes, mechanism for controlling and regulating the electrodes to maintain a normal arc, and means associated with the regulating and controlling mechanism for repeatedly raising and releasing the upper  
35 electrode and permitting it to drop by gravity upon the lower electrode until the electrodes make electrical contact with each other.

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

THOMAS EDGAR ADAMS.

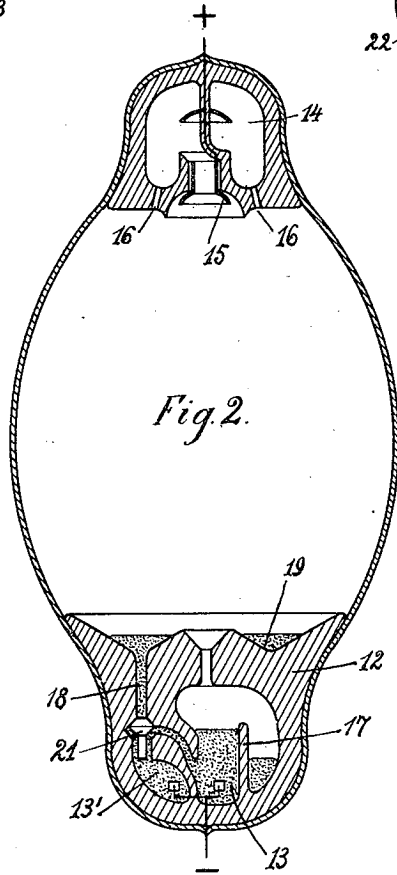
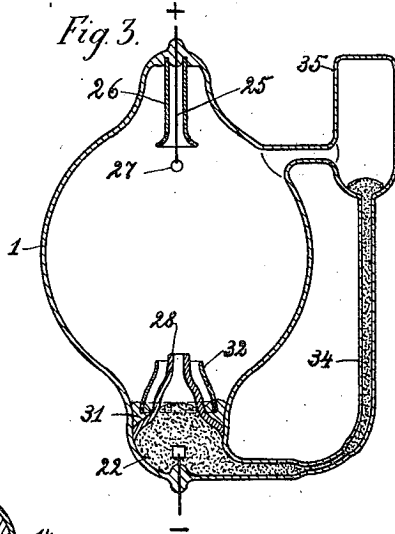
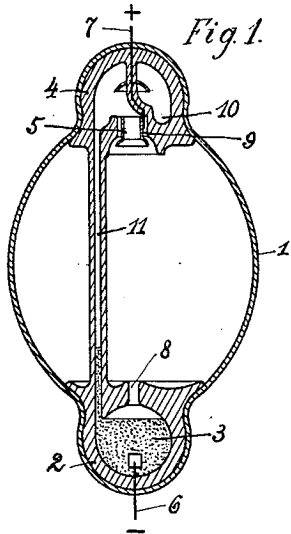
Witnesses:

J. H. WORBS,  
JOHN R. ORPUTT.

E. PODSZUS.  
 ELECTRIC VAPOR APPARATUS.  
 APPLICATION FILED OCT. 4, 1909.

1,076,058.

Patented Oct. 21, 1913.



Witnesses:  
 E. C. Schuermann.  
*[Signature]*

Inventor:  
 Emil Podszus.  
*[Signature]*

# UNITED STATES PATENT OFFICE.

EMIL PODSZUS, OF RIXDORF, NEAR BERLIN, GERMANY.

## ELECTRIC VAPOR APPARATUS.

1,076,058.

Specification of Letters Patent.

Patented Oct. 21, 1913.

Application filed October 4, 1909. Serial No. 520,924.

To all whom it may concern:

Be it known that I, EMIL PODSZUS, a subject of the Emperor of Germany, residing at Rixdorf, near Berlin, in the Kingdom of Prussia, Germany, have invented certain new and useful Improvements in Electric Vapor Apparatus; 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 improvements in electric vapor apparatus, and more particularly to improvements in electric vapor arc lamps.

The objects of the improvements are first to furnish an apparatus, in which the temperature and therefore the luminous power of the arc are increased, and second to so construct the apparatus, that the casing inclosing the same, which in case of a lamp consists of glass, is in a less degree exposed to the destructive influence of the vapor, or is entirely protected against the same, so that the durability of the apparatus is greatly increased.

With these and other objects in view my invention consists in the matters described hereinafter and particularly pointed out in the appended claims.

For the purpose of explaining the invention several examples embodying the same have been shown in the accompanying drawing in which the same letters of references have been used in all the views to indicate corresponding parts.

In said drawing, Figure 1, is a vertical section of an apparatus, and Figs. 2 and 3, are vertical sections of modifications of the same.

Broadly speaking the invention consists in providing means, whereby the vapor is forced to traverse the casing or glass bulb in a narrow jet which is prevented from deviating from its direction and from coming in contact with the wall of the casing. Suitable means for so conducting the vapor consist in a chamber inclosing the metal forming the cathode and provided with an aperture acting as a nozzle and directing the vaporized metal toward the anode.

Referring to the example shown in Fig. 1 and illustrating an arc lamp, 1 indicates the glass bulb or envelop which incloses at its lower end a hollow body 2 receiving the cathode 3 and at its upper end a similar hol-

low body 4 receiving the anode 5. By conductors 6 and 7 the cathode and the anode are connected to the circuit supplying the electric current. The cathode 3 consists of a vaporizable metal, such for example as sodium, mercury, etc. The chamber inclosing the cathode communicates with the hollow of the glass bulb through an aperture or nozzle 8 made in the upper wall of the hollow body 2 and directed upward toward the anode 5. In a similar way the chamber inclosing the anode 5 is formed with an aperture 9. As shown the said aperture receives the anode 5 which is constructed in the form of a sleeve. The lower part of the hollow body 4 is formed with an annular channel 10 surrounding the aperture 9, and communicating at its bottom with the hollow body 2 through a tube 11. The hollow bodies 2 and 4 are made of suitable refractory material, such for example as magnesia. The tube is not necessarily made of refractory material, but of such non-conductive substances as are not affected by the destructive influence of the metal forming the anode. If, for example, the latter consists of mercury, the said tube may be made of glass, while in the case of sodium it is made of magnesia, zirconium, oxid of thorium, etc. The anode is made of a material of a high fusing point, such for example as iron, carbon, etc.

When using the lamp, the mercury or sodium forming the cathode is vaporized by the heat of the arc, and it produces a certain pressure within the hollow body, because the aperture 8 of the latter is small. By the said pressure the vapor is forced through the aperture or nozzle 8 and it passes through the hollow of the glass bulb 1 to the anode 5 in the form of a jet of small cross-sectional area, without coming in contact with the wall of the glass bulb 1. Within the hollow body 4 the vapor is condensed and it is deposited on the channel 10 from which it flows downward through the tube 11 and back into the hollow body 2. When thus flowing downward through the tube 11 the condensed vapor or metal acts by its static pressure on the metal or vapor contained within the hollow body 2.

In the example illustrated in Fig. 2, the tube 11 shown in Fig. 1 is dispensed with. Instead of the latter fine apertures 16 are made in the bottom wall of the hollow body 14 inclosing the anode 15, and the upper face of the hollow body 12 is in the form

of an annular channel 19 adapted to gather the condensed metal dropping downward through the apertures 16. By an annular partition wall 17 the chamber formed by the hollow body 12 is divided into two concentric sections 13 and 13'. The inner section 13 forms the main reservoir for the metal forming the cathode, and the outer annular section 13' surrounding the former provides a subsidiary reservoir for the said metal. Through a canal 18 the section 13 communicates with the annular channel 19, so that the condensed metal deposited on the said channel can flow into the section 13. The metal contained within the main reservoir 13 is at a higher level than that contained within the subsidiary reservoir 13'. Normally the canal 18 is closed by a valve 21 which floats within the metal of the subsidiary reservoir 13' and is thereby held in its closing position.

If the arc is started within the lamp in any known way, the metal contained within the hollow body 12 is vaporized, and the arc is formed from the metal within the subsidiary reservoir 13' and from that contained within the main reservoir 13. The latter, however, vaporizes in a greater degree, because it is at a higher level. If the vaporization has proceeded so far, that the level is nearly the same in both reservoirs, the valve is forced downward by the pressure of the mercury gathered within the canal 18. Therefore the metal gathered within the said canal and in the channel 19 flows downward into the main reservoir 13, so as to fill the same. From the latter a part of the metal flows over the partition wall 17 into the subsidiary reservoir 13', so that the level of the latter is raised, the pressure is increased, and the valve is again lifted into its closing position.

The electric arc passing from the metal of the reservoir 13' surrounds the main reservoir 13, so as to heat the metal contained therein and to raise the pressure of the vapor.

The aperture or nozzle of the hollow body containing the cathode is exposed to very high temperatures. It is therefore preferably made of substances of a high fusing point, for example of carbon, tungsten, tantalum, or molybdenum. In some cases it is advisable to cool the same, so that it can not be destroyed by the heat. In this case the temperature of the arc can be increased, and thus the character of the light be varied. The cooling of the nozzle is preferably effected by gathering condensed metal near the same, which by its vaporization cools the nozzle, or by locating metallic bodies having large cooling surfaces near the said nozzle. To show what may be done in this respect, an example of a lamp provided with such cooling means is illustrated in Fig. 3. As

shown in said figure, the cathode is inclosed within a chamber 22 communicating with the hollow of the glass bulb through a nozzle 28 of refractory material. Near the said nozzle metallic bodies 31 are located from which metallic cooling elements 32 extend upward. Also the anode is constructed in a manner different from that described with reference to Figs. 1 and 2. It consists of a thin conductor 25 protected by a tubular body 26 of refractory material and having an enlarged lower end 27 of a material of a high fusing point, such for instance as tungsten, molybdenum, or zirconium. An anode of this construction is brought to glowing temperature by the electric arc, so that it partakes of the emission of light.

To prevent the metal flowing back to the cathode from being vaporized by radiation, the tube 34 conducting the same backward is preferably located entirely outside the glass bulb. As shown it is formed at its upper end with an enlarged portion 35 communicating with the upper part of the glass bulb and forming a condensing chamber. Near the chamber inclosing the cathode the tube 34 is contracted to capillary form, so that in case of variations in the pressure of the vapor within the metal of the cathode the latter can not be forced into the tube 34, and oscillations of the metal are avoided. By such oscillations the lamp might easily be extinguished.

The lamp is either evacuated, or it is filled with some indifferent gas, such for instance as argon.

I claim:

1. In electric vapor arc apparatus, an envelop, electrodes in the same, one of which is vaporizable, and a chamber associated with the vaporizable electrode to retain the unvaporized portion thereof and having a restricted outlet for the discharging vapor and a return passage for the condensed vapor, whereby the vapor is forced to traverse the envelop, toward the other electrode, in a narrow jet which is independent of the form of the envelop; substantially as described.

2. In electric vapor arc apparatus, an envelop, a non-vaporizable electrode therein, a vaporizable electrode in the envelop, and a hollow body to contain the vaporizable electrode and having a restricted outlet nozzle directed toward the non-vaporizable electrode, and a return passage for the condensed vapor, whereby the vapor is forced to traverse the envelop, toward the other electrode, in a narrow jet which is independent of the form of the envelop; substantially as described.

3. In electric vapor arc apparatus, an envelop, a non-vaporizable electrode therein, a vaporizable electrode in the envelop, and a hollow body to contain the vaporizable electrode and having a restricted outlet nozzle

directed toward the non-vaporizable electrode, and a return passage for the condensed vapor, whereby the vapor traverses the envelop in an endless stream; substantially as described.

4. In electric vapor arc apparatus, an envelop, a vaporizable electrode therein, a non-vaporizable electrode therein, and a hollow body of refractory material to contain the non-vaporized portion of the vaporizable electrode, said body being of greater volume than said non-vaporized portion when the apparatus is in operation and having a restricted outlet nozzle at one point and a return passage for the condensed vapor at another point; substantially as described.

5. In electric vapor arc apparatus, an envelop, a non-vaporizable electrode therein, a vaporizable electrode therein, a hollow body to contain the non-vaporized portion of the vaporizable electrode when the apparatus is in operation, and having a restricted outlet nozzle from which the vapor is discharged toward the other electrode in the form of a narrow jet, said body being also provided with a separate return passage for the condensed vapor, and a hollow body associated with the non-vaporizable electrode and into which the condensed vapor enters, said last named body having means to discharge the condensed vapor toward the aforesaid return passage of the first named body; substantially as described.

6. In electric vapor arc apparatus, the combination of an envelop, a vaporizable electrode, a non-vaporizable electrode, and a hollow body to which the non-vaporizable electrode is secured with a free passage around the same communicating with said body, said hollow body serving to receive the condensed vapor, and having means offset from the non-vaporizable electrode to

discharge such condensed vapor continuously during the operation of the apparatus; substantially as described.

7. In an electric vapor arc apparatus, the combination with an electrode of vaporizable material, and a second electrode of non-vaporizable material having the form of a sleeve, of a hollow body forming a condensing chamber and inclosing the non-vaporizable electrode within an aperture for the passage of the vapor, and means to cause the vapor to flow between said electrodes in the form of a narrow jet.

8. In electric vapor arc apparatus, the combination of an envelop, electrodes therein, one of which at least is vaporizable, means in the envelop to cause the vapor to traverse the latter in a narrow jet-like stream independent of the form of the envelop, means independent of the jet forming means for returning the condensed vapors to the vicinity of the jet forming means, and a body of indifferent gas in the envelop, through which such stream passes; substantially as described.

9. In an electric vapor arc apparatus, the combination of an envelop, electrodes in the same, one of which consists of vaporizable material, a hollow body inclosing said vaporizable electrode, and having an aperture which is adapted to direct the vapor discharged from said hollow body to the other electrode in the form of a narrow jet, the wall of said aperture being formed of material of high fusing point.

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

EMIL PODSZUS.

Witnesses:

HENRY HASPER,  
WOLDEMAR HAUPT.

R. FLEMING & C. A. B. HALVORSON, JR.

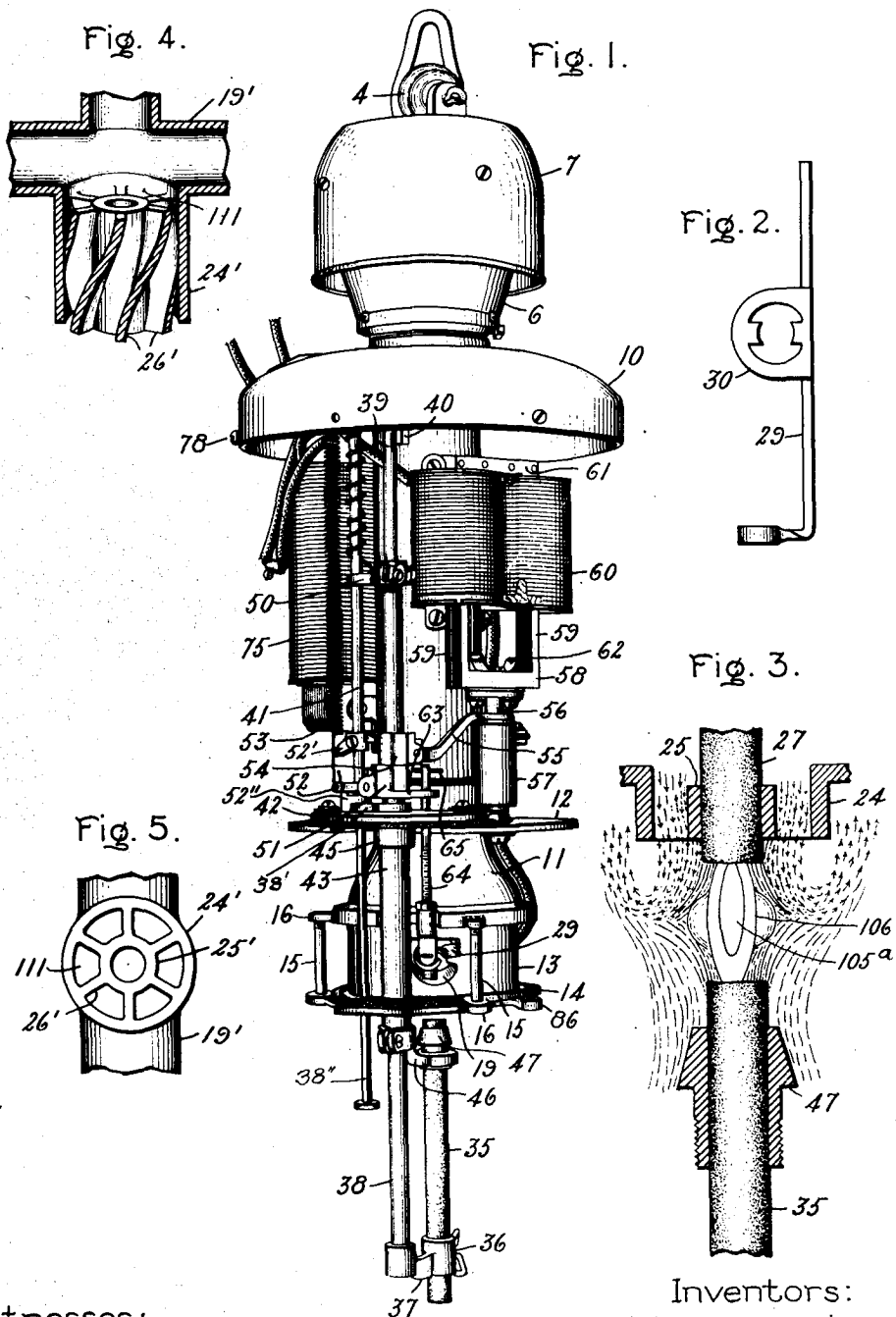
ARC LAMP.

APPLICATION FILED MAR. 6, 1905.

1,078,913.

Patented Nov. 18, 1913.

3 SHEETS—SHEET 1.



Witnesses:

*George W. Tilden.*  
*Allen Orford*

Inventors:

Richard Fleming,  
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by *Albert H. Davis*  
Att'y

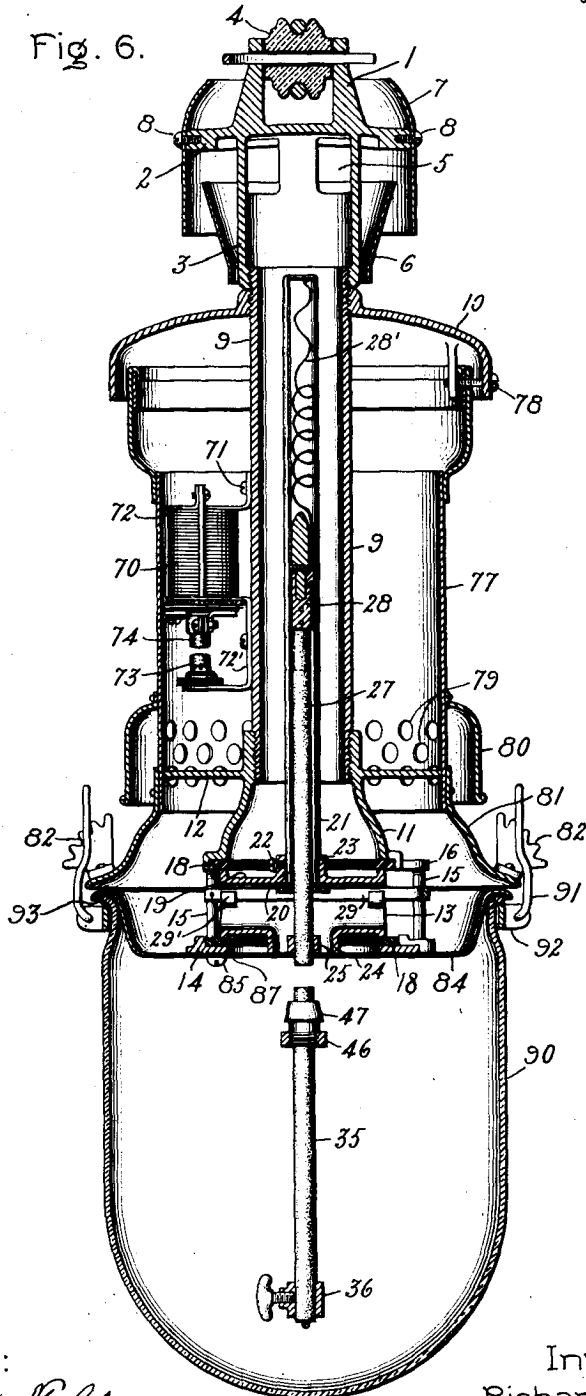
R. FLEMING & C. A. B. HALVORSON, JR.  
ARC LAMP.

APPLICATION FILED MAR. 6, 1905.

1,078,913.

Patented Nov. 18, 1913.

3 SHEETS—SHEET 2.



Witnesses:

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R. FLEMING & C. A. B. HALVORSON, JR.

ARC LAMP.

APPLICATION FILED MAR. 6, 1905.

1,078,913.

Patented Nov. 18, 1913.

3 SHEETS-SHEET 3.

Fig. 7.

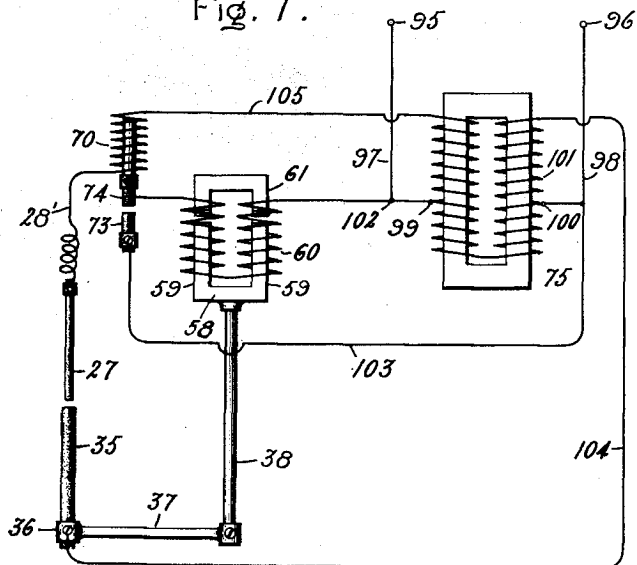


Fig. 8.

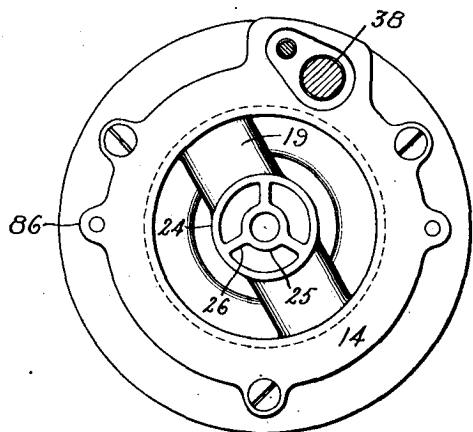
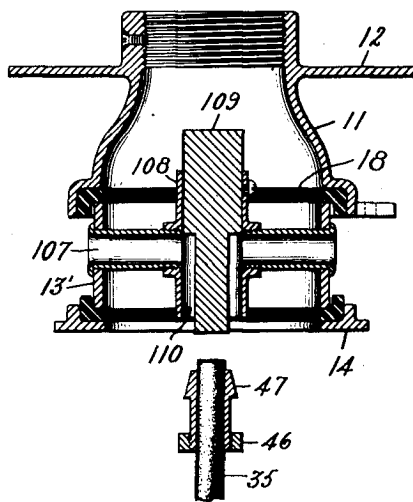


Fig. 9.



Witnesses:

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*Helen Oxford*

Inventors:

Richard Fleming.  
Cromwell A.B. Halvorson, Jr.  
by *Albert S. Davis*  
Att'y.



# UNITED STATES PATENT OFFICE.

RICHARD FLEMING AND CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

1,078,913.

Specification of Letters Patent.

Patented Nov. 18, 1913.

Application filed March 6, 1905. Serial No. 248,549.

*To all whom it may concern:*

Be it known that we, RICHARD FLEMING and CROMWELL A. B. HALVORSON, Jr., citizens of the United States, residing, respectively, at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

Our present invention relates to arc lamps, and more particularly to arc lamps in which the electrodes employed are of such a character that a flaming or luminous arc is obtained.

We have found that with electrodes so arranged that the axis of the arc is vertical, as in the ordinary case, it is sometimes highly desirable to produce air currents which pass downward by the arcing surface or end of the upper electrode. For instance when, as is sometimes desirable, the lower electrode is formed of carbon or other analogous material, and the upper electrode is a consuming electrode containing or composed of one or more materials such as the so-called light-giving salts, the ascending currents of air produced by the heat of the arc tend to carry the light-giving vapors or particles generated or set free from the upper electrode out of the arc path unless especial means are taken to prevent it. When this occurs the vapors or particles cool and cease to give off light. As a result the lower end of the arc is less luminous than it should be. By producing a downwardly moving tube or shell of air or gas enveloping the upper end of the arc, the light-giving vapors or particles are held in the arc for a longer period and the efficiency of the arc as a light-producing agency is greatly increased. Moreover by this arrangement the upper end of the arc is steadied.

By a suitable proportioning and arrangement of parts a down draft by the lower end of the upper electrode and an up draft along the upper end of the lower electrode are obtained. Such an arrangement tends to steady the arc at both ends, thus rendering the light-giving arc more stable. Moreover with this arrangement the arc for a certain portion of its length between its ends is surrounded by an annular mass or body of hot air or gas which is practically motionless. This increases the efficiency of the arc and steadies it.

With a draft by the arcing end of each

electrode toward the opposite electrode the temperatures of the electrodes are decreased and their consumption lessened. The results of a cooling draft by the arcing end of an electrode are especially marked where the electrode is formed of or contains some material such as titanium carbide and a relatively powerful draft is employed such as the down draft by the upper electrode obtained with the mechanism hereinafter described in detail.

Where one and only one of the electrodes gives off fumes which tend to condense in a solid form upon adjacent surfaces such as the sides of the electrodes, the tendency to condensation is reduced by placing the fume emitting electrode above the cooperating electrode. By causing a draft of air to pass by the arcing end of each electrode toward the opposite electrode the tendency to condensation upon the sides of either of the electrodes is almost entirely done away with as the fumes are carried outward from the arc at the junction of the two moving bodies of air or gas. It will be readily apparent to all those skilled in the art that some of the advantages of a down draft will be obtained when the lower electrode is composed of or contains material, such as light-giving salts, giving a flaming or luminous arc. In particular we have found the use of a down draft to be sometimes of considerable value when an upper electrode so constructed as to be non-consumed by the operation of the arc is used in conjunction with a lower electrode composed of or containing materials giving a flaming or luminous arc.

In the accompanying drawings and descriptive matter we have shown an arc lamp structure in which means are provided for obtaining a down draft by the lower end of the upper electrode to obtain advantages described above. The lamp mechanism which we have described and illustrated also possesses many novel features of construction and arrangement.

While the various features of novelty which characterize our present invention are pointed out with particularity in the claims annexed to and forming a part of this specification, reference should be had to the accompanying drawings and description for a full understanding of our invention.

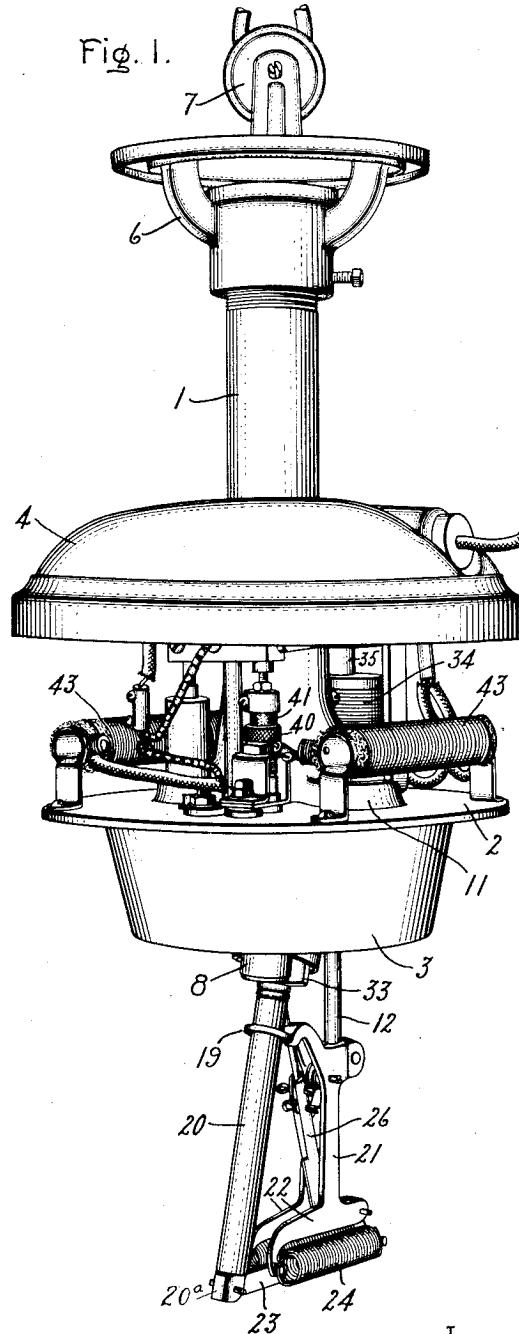
Of the drawings, Figure 1 is a perspec-

C. A. B. HALVORSON, JR.  
ARC LAMP.  
APPLICATION FILED JULY 21, 1910.

1,107,061.

Patented Aug. 11, 1914.

3 SHEETS-SHEET 1.



Witnesses:

*George W. Tilden*  
*J. Ellis Klen*

Inventor:

Cromwell A. B. Halvorson Jr.,

by *Alfred G. Davis*  
His Attorney.

Fig. 2.

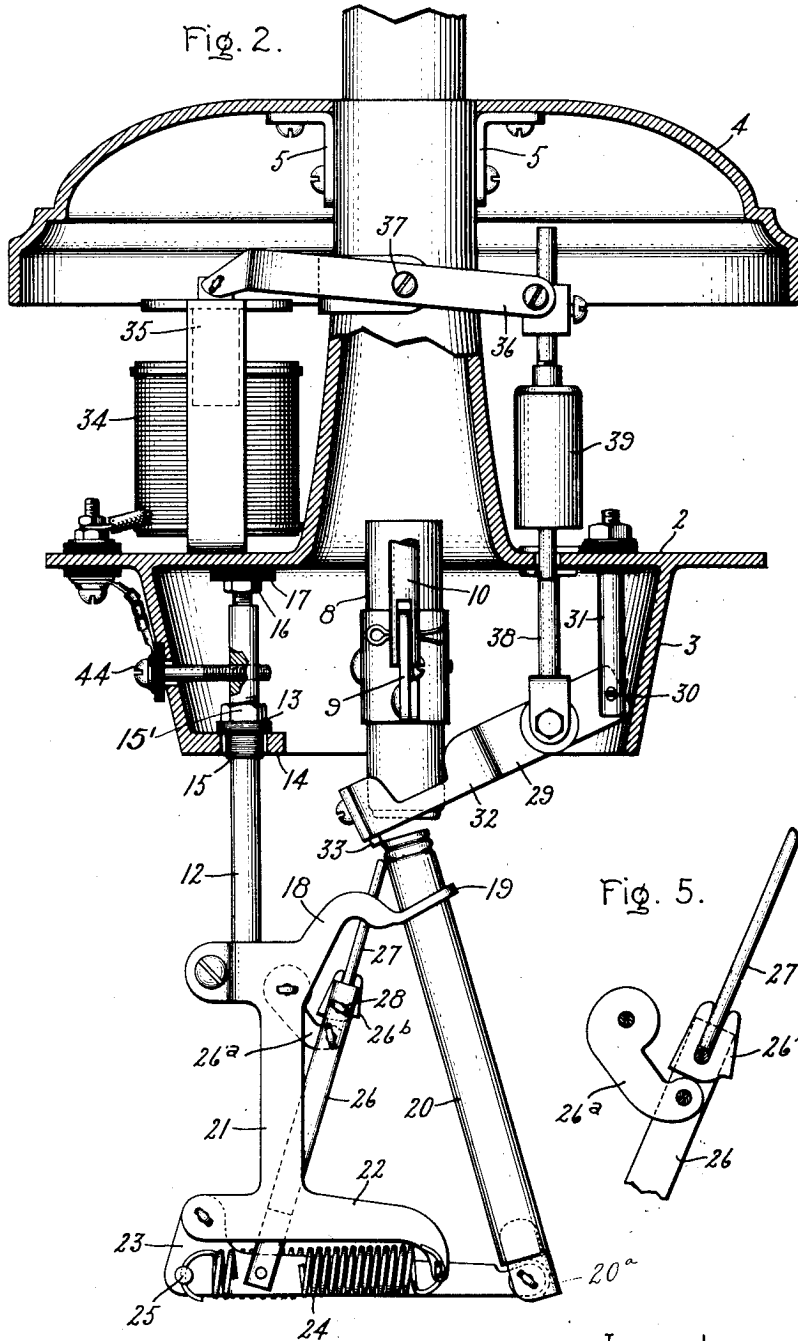
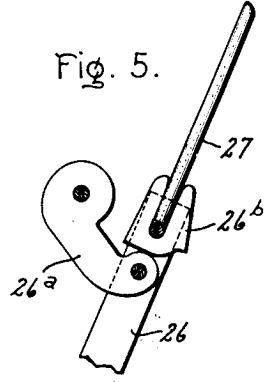


Fig. 5.



Witnesses:

*George H. Tilden*  
*J. Ellis Elen*

Inventor:

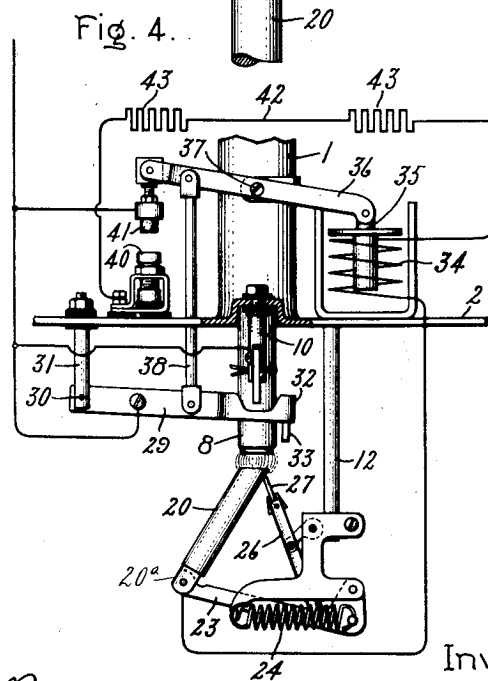
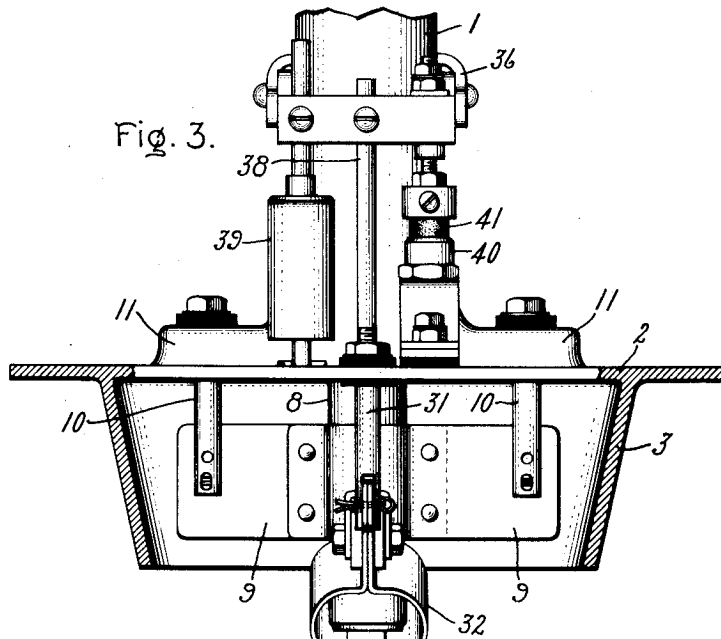
Cromwell A. B. Halvorson Jr.,  
by *Albert S. Darn*  
His Attorney.

C. A. B. HALVORSON, JR.  
 ARC LAMP.  
 APPLICATION FILED JULY 21, 1910.

1,107,061.

Patented Aug. 11, 1914.

3 SHEETS-SHEET 3.



Witnesses:

*George W. Tilden*  
*J. Ellis Elm*

Inventor:

Cromwell A. B. Halvorson Jr.,

by *Alfred G. Davis*  
 His Attorney.

# UNITED STATES PATENT OFFICE.

CROMWELL A. B. HALVORSON, JR., OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

1,107,061.

Specification of Letters Patent. Patented Aug. 11, 1914.

Application filed July 21, 1910. Serial No. 573,015.

To all whom it may concern:

Be it known that I, CROMWELL A. B. HALVORSON, Jr., a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

This invention relates to electric arc lamps, and especially to those of the flaming or luminous arc type.

The object of the invention is to provide a lamp which is simple in construction, durable in service and not liable to get out of order.

The features of novelty will appear from the following description and the appended claims.

In the accompanying drawings, Figure 1 is a perspective view of my improved lamp, with the outer casing removed; Fig. 2 is a sectional elevation of the working parts of the lamp on a larger scale; Fig. 3 is a sectional elevation taken at right angles to Fig. 2; Fig. 4 is a side elevation of a portion of the regulating mechanism with a diagram of the circuits of the lamp; and Fig. 5 is a sectional detail view.

The frame of the lamp comprises a central chimney 1 whose lower end is somewhat flaring and is provided with a circumferential horizontal flange 2 from which depends a circular wall 3, preferably sloping inward somewhat, as shown. A canopy 4 surrounds the chimney a suitable distance above the flange 2, and is attached to said chimney, as by means of the brackets 5. The canopy extends preferably beyond the periphery of the flange to afford a support for the casing and globe holder, which are not shown in the drawings. To the upper end of the chimney is secured a spider 6, carrying the usual dead-eye 7 by means of which the lamp is suspended.

The upper non-consuming electrode 8 is a massive stick of metal, preferably of copper, and is provided with laterally-projecting webs 9 which are secured to insulated hangers 10 depending from the flange 2. In order to give an unobstructed entrance to the chimney above these webs, the flange is pref-

erably arched above them on each side of the chimney, as shown at 11. The lower consuming electrode is supported by a rod 12 which passes through a lug 14 extending inwardly from the flange 3. The rod 12 is insulated from the lug 14 by a bushing 15, the upper portion of which is provided with a flange 13 of greater diameter than the opening in the lug 14 through which the bushing passes. The rod 12 and the parts carried thereby are supported by a nut 15' which engages a threaded portion of the rod 12 immediately above the bushing. A jam screw in the upper end of the rod bears against the plate 17 of insulating material placed against the underside of the flange 2. The lower end of the rod carries a frame 18, which has a guide 19 for the lower electrode 20, and comprises also two depending legs 21, having feet 22. The upper end of the electrode shell is beaded to hold in position the usual metal disk which prevents the magnetite mixture from falling out. Between the heels of these feet is fulcrumed a lever 23, preferably L-shaped, with its long horizontal arm pivoted to a plate 20<sup>a</sup>, which is received in the lower end of the electrode 20. Tension springs 24 are attached to the toes of the feet 22 and to pins 25 at the angle of the L-shaped lever 23, so that said springs tend to lift the long arm of the lever and urge the electrode 20 upwardly. The lower bifurcated end of a member 26 receives the inner end of the lever 23 and is pivoted thereto. The upper end of the member 26, which is also bifurcated, is connected to the legs 21 by a link 26<sup>a</sup>, the outer end of which is pivoted between the prongs at the upper end of the member 26, and the inner end of which is pivoted between the legs 21. A flat piece 26<sup>b</sup>, provided with two upwardly directed jaws, as shown in Fig. 5, is secured at the upper end of the member 26 between its prongs by a cotter pin 28, and this member rests upon the outer end of the link 26<sup>a</sup>. The pin 27 is received between the upper prongs of the member 26 and between the two jaws of the member 26<sup>b</sup>. The upper ends of the lower electrode 20 and the pin 27 pass through the opening in the guide 19,

and as they converge and are impelled upwardly by the springs 24 the pin 27 will be wedged against the upper end of the lower electrode 20. The pin 27 is consumed, together with the lower electrode, but much more slowly, and is renewed with the lower electrode when the lamp is trimmed. It will thus be understood that the distance of the lower electrode from the upper one is kept constant, and the arcing face of the upwardly-feeding lower electrode remains stationary.

Inasmuch as the electrodes are stationary, so far as their tips are concerned, means must be provided for striking the arc. Moreover, in flaming arc lamps, a non-conducting crust is liable to form on the end of the composition electrode when it cools, and as this is of high electrical resistance, means must also be provided for breaking this crust off when the lamp is started, in order to permit the current to flow freely. I accomplish both the breaking of the crust and the striking of the arc by means of a lever 29 fulcrumed at 30 within the wall 3, and preferably on an insulated pin 31 depending from the flange 2. The free end of the lever is a ring 32 encircling the electrodes and carrying a finger 33 which comes in contact with the lower electrode 20 when the lever is dropped to the position shown in Fig. 2; the position it occupies when the lamp is out. The lever drops suddenly to this position, and the blow of the finger on the end of the electrode 20 chips off any crust which may have formed there, so that said finger rests in good electrical contact with said electrode. The lever is electrically connected to the same side of the line as the upper electrode, so that when the current is turned on the circuit is at once established.

The striking of the arc is effected by the electromagnet 34 whose movable core 35 is attached to one end of a beam 36, pivoted at 37 on the sides of the chimney, which said beam straddles. The other end of said beam is connected by a pitman 38 with the lever 29 at a point between the fulcrum 30 and the ring 32. When the lamp circuit is closed, the electromagnet pulls down its core and this causes the lever 29 to be lifted, drawing the finger 33 away from the lower electrode and establishing the arc, which at once shifts from said finger to the upper electrode. A dash-pot 39 is connected with one end of the beam and serves to retard the movements of the beam and the lever 29 in striking the arc, so that there is no danger of its being snapped out by too quick a motion of the finger.

In the operation of certain types of flaming or luminous arc lamps, particularly the magnetite lamp, copious fumes are emitted

from the arc and a flocculent-like deposit is formed about the upper electrode. The movement of the arm 29 removes this deposit from the upper electrode. The beam 36 also serves to operate the automatic cut-out of the lamp, which consists of the two contacts 40, 41 located in a short circuit across the lamp, containing suitable resistors 43. The contact 40 is stationary, while the other one is attached to the beam so that when the current is turned on this short circuit will be opened.

By referring to Fig. 4, it will be seen that one side of the line is connected to the contact 41 and also to the upper electrode 8 and the lever 29, while the other side of the line is connected to the other contact 40 through the resistors 43, and also to the electromagnet 34 and thence to the lower electrode; preferably by means of an insulated screw 44 passing through the wall 3 and tapped into the rod 12.

I do not claim the lower electrode and the mechanism associated therewith for impelling the same upwardly, as this is a joint invention of John T. Beechlyn and myself, for which a separate application, Serial No. 688,180 has been filed.

It will be seen that this lamp is quite simple in construction, and that the electromagnet, dash-pot and cut-out are protected from the heat and fumes of the arc by the flange 2 and the wall 3; the fumes passing freely up the chimney which is directly above the arc whose stationary position is an advantage. The moving parts are few, and all are readily accessible for inspection or repair, and the lamp is compact and attractive in appearance.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In a flaming or luminous arc lamp, the combination with electrodes the arcing faces of which are out of contact and substantially stationary, one above the other, an electromagnet, a lever movable thereby and carrying at one end a ring loosely embracing one of the electrodes and adapted in operation to remove arc deposits therefrom, said ring being provided with a conducting finger which in one position of the lever engages one of the electrodes and in the other position is adjacent to the other electrode.

2. In an arc lamp, an upper non-consuming electrode, a lower consuming electrode upon which a non-conducting layer is liable to form during the operation of the lamp, a lever free to move in one direction by gravity and provided at its free end with a pin adapted to forcibly engage and break the non-conducting layer at the arcing end of the consuming electrode when the lever moves under the action of gravity, an elec-

tromagnet for moving the lever against gravity and thereby starting an arc between the pin and the lower electrode, said lever being proportioned and arranged to bring  
5 the conducting pin in arc-transferring proximity to the upper electrode when the lever is moved by the magnet.

In witness whereof, I have hereunto set my hand this 18th day of July, 1910.

CROMWELL A. B. HALVORSON, JR.

Witnesses:

JOHN A. McMANUS, JR.,

CHARLES A. BARNARD.

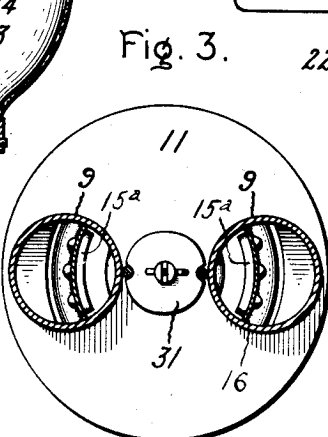
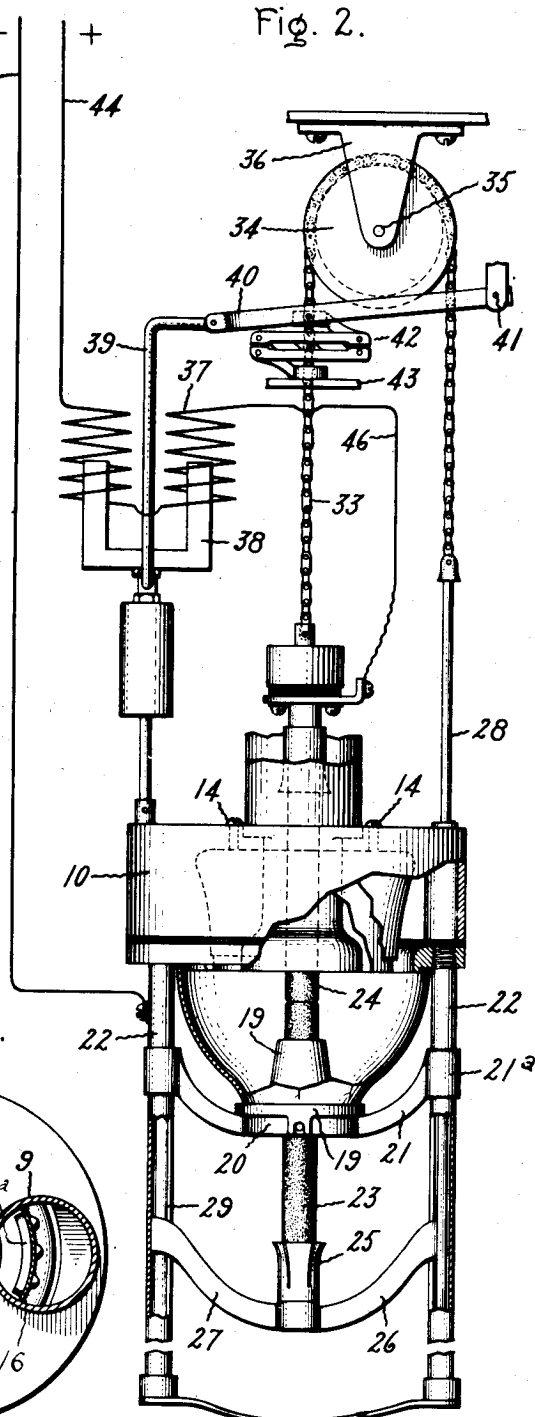
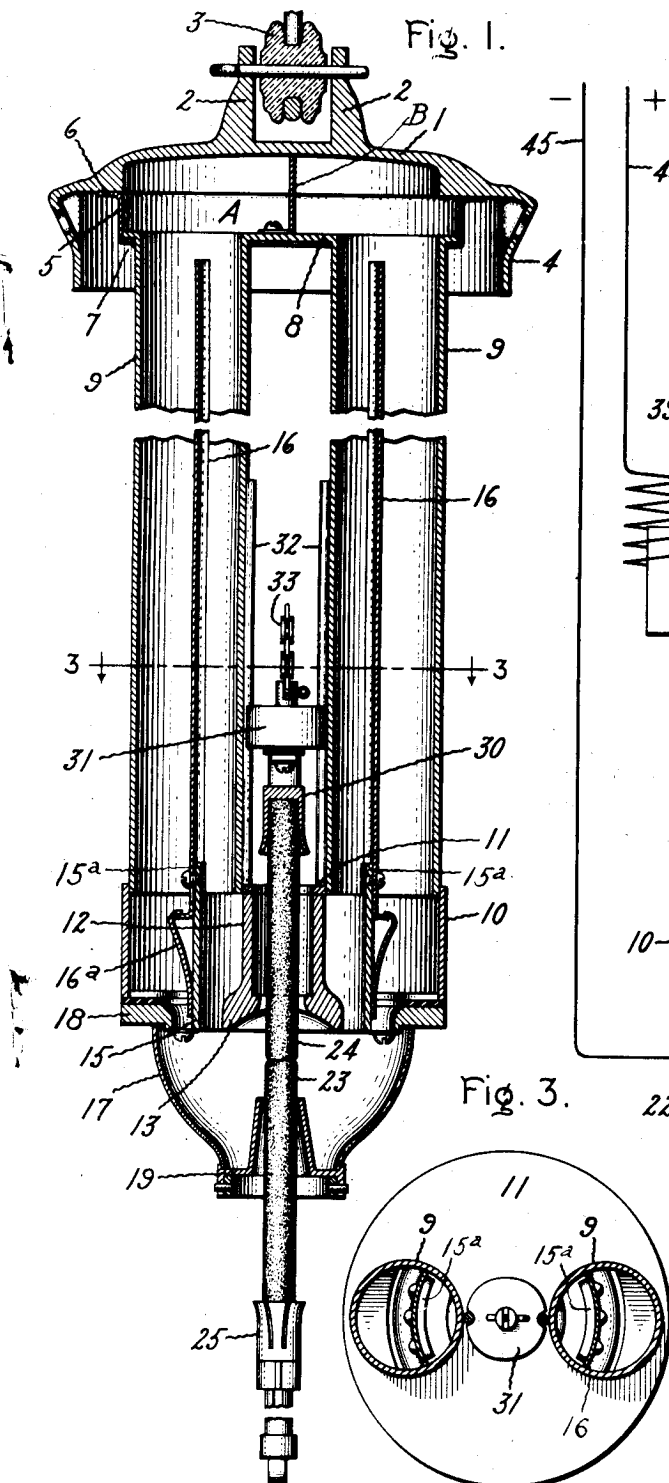
E. J. GUAY.

ARC LAMP.

APPLICATION FILED OCT. 25, 1912.

1,142,251.

Patented June 8, 1915.



Witnesses:

*George W. Tilden*  
*J. Ellis Egan.*

Inventor:

Emile J. Guay,

by *Albert S. Davis*  
His Attorney.



# UNITED STATES PATENT OFFICE.

EMILE J. GUAY, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

1,142,251.

Specification of Letters Patent.

Patented June 8, 1915.

Application filed October 25, 1912. Serial No. 727,730.

*To all whom it may concern:*

Be it known that I, EMILE J. GUAY, a citizen of the United States, residing at Swampscott, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

My invention has reference to an arc lamp, and more particularly to an inclosed arc lamp of the flaming or luminous type.

In accordance with my invention a novel arc inclosure is provided, which is simple and efficient, comprising passages leading from and to the globe through which the products of combustion pass and where they may deposit before they come in contact with the inclosing globe.

For a fuller understanding of my invention, reference is had to the accompanying drawings, in which—

Figure 1 is a vertical section of an arc lamp embodying my invention; Fig. 2 is a side elevation at right angles to Fig. 1, showing parts of the lamp in section and other parts broken away and still other portions of the lamp omitted altogether in order to more clearly illustrate my invention; and Fig. 3 is a sectional plan view on the line 3—3, Fig. 1.

In the drawings, referring first particularly to Fig. 1, 1 is the canopy of the lamp provided with up-standing lugs 2, from which the lamp is supported by a usual form of insulated pulley 3. The canopy is provided with a downwardly extending peripheral flange 4, within which a suitable casing for the lamp may be received. A short cylindrical plate 5 is provided with an outwardly extending flange 6 at its top, by which the plate is secured to the under side of the canopy 1. The bottom of this plate is provided with an inwardly extending annular flange 7, on which is supported a top plate 8. Two tubes 9 are suspended from the plate 8 and register with openings therein. I have here shown the tubes and plate 8 as integral, but it is obvious that the tubes may be secured to the plate in any suitable manner. The lower ends of the tubes 9 communicate with a drum 10, which is closed at the top at 11. A cylindrical sleeve 12 which is enlarged at its bottom to form an economizer 13 for the arc surrounds the upper electrode and is located within and substantially coextensive with

the drum 10. This cylindrical sleeve is secured to the top plate 11 of the drum by suitable lugs and screws 14. An annular partition 15 divides the space between the cylindrical portion of the drum 10 and the sleeve 12 into two annular passages. Transverse partitions 16 are also provided for the tubes 9, which are secured to ears 15<sup>a</sup> with which the partition 15 is provided, the partitions of the tubes thus being substantially in alinement with the annular partition 15. These partitions terminate at a point not far from the upper ends of the tubes, preferably a little short of the upper ends, whereby the two passages formed by the partition in a given tube are in free communication with each other at the upper ends of the tubes as well as within the chamber A formed by the canopy 1 and the plate 5 and the top plate 8 through which the tubes 9 pass. The chamber A is preferably divided into two parts by a vertical partition B. An annular plate 16<sup>a</sup> having its lower end inclined inwardly to fit snugly about the partition 15 is supported by an inwardly turned flange at the top which engages an outwardly turned flange on the bottoms of the partitions 16. This plate 16<sup>a</sup> is formed to deflect the downwardly flowing current of gases in the outer sections of the tubes outwardly against the cool walls of the tubes 9, thereby promoting a rapid circulation of the gases in the tubes and the inclosing globe, which tends to prevent deposit of the fumes on the globe. It will also be observed that an air space is formed between the partition 15 and the plate 16<sup>a</sup>, which tends to prevent radiation from the partition and thereby promote the rapid circulation of gases by increasing the temperature difference between the gases in the outer and inner sections of the drum and tubes. A light-transmitting globe 17 is seated at the top against a plate 18 supported and insulated from the drum 10. The opening at the bottom of the globe is closed by a plate 19 having an upturned inwardly flaring sleeve snugly surrounding the lower electrode. The plate 19 is in turn supported from an annular ring 20 carried by arms 21, the outer ends of which are provided with sleeves 21<sup>a</sup> by which the globe seat is secured to two sleeves 22 passing through and secured to the drum 10.

The lower and upper electrodes are repre-

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C. A. B. HALVORSON, JR. & J. T. BEECHLYN.

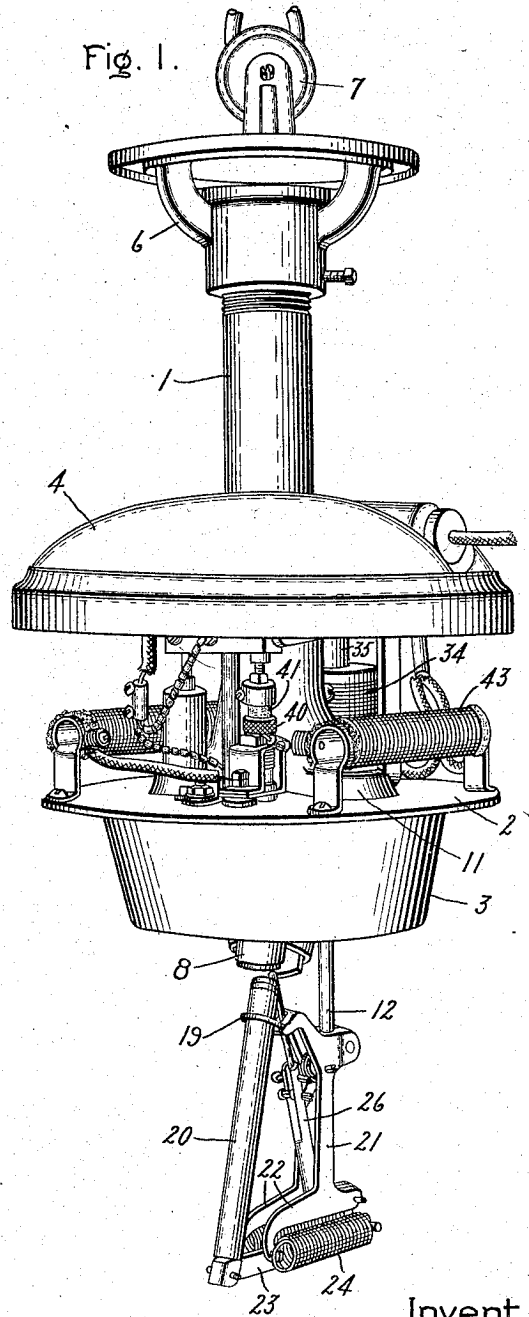
ARC LAMP.

APPLICATION FILED APR. 3, 1912.

1,171,193.

Patented Feb. 8, 1916.

3 SHEETS—SHEET 1.



Witnesses:

*Earl G. Klock*

*J. Ellis*

Inventors:

Cromwell A. B. Halvorson Jr.,

John T. Beechlyn,

by *Albert H. Davis*

Their Attorney

C. A. B. HALVORSON, JR. & J. T. BEECHLYN.

ARC LAMP.

APPLICATION FILED APR. 3, 1912.

1,171,193.

Patented Feb. 8, 1916.

3 SHEETS—SHEET 2.

Fig. 2.

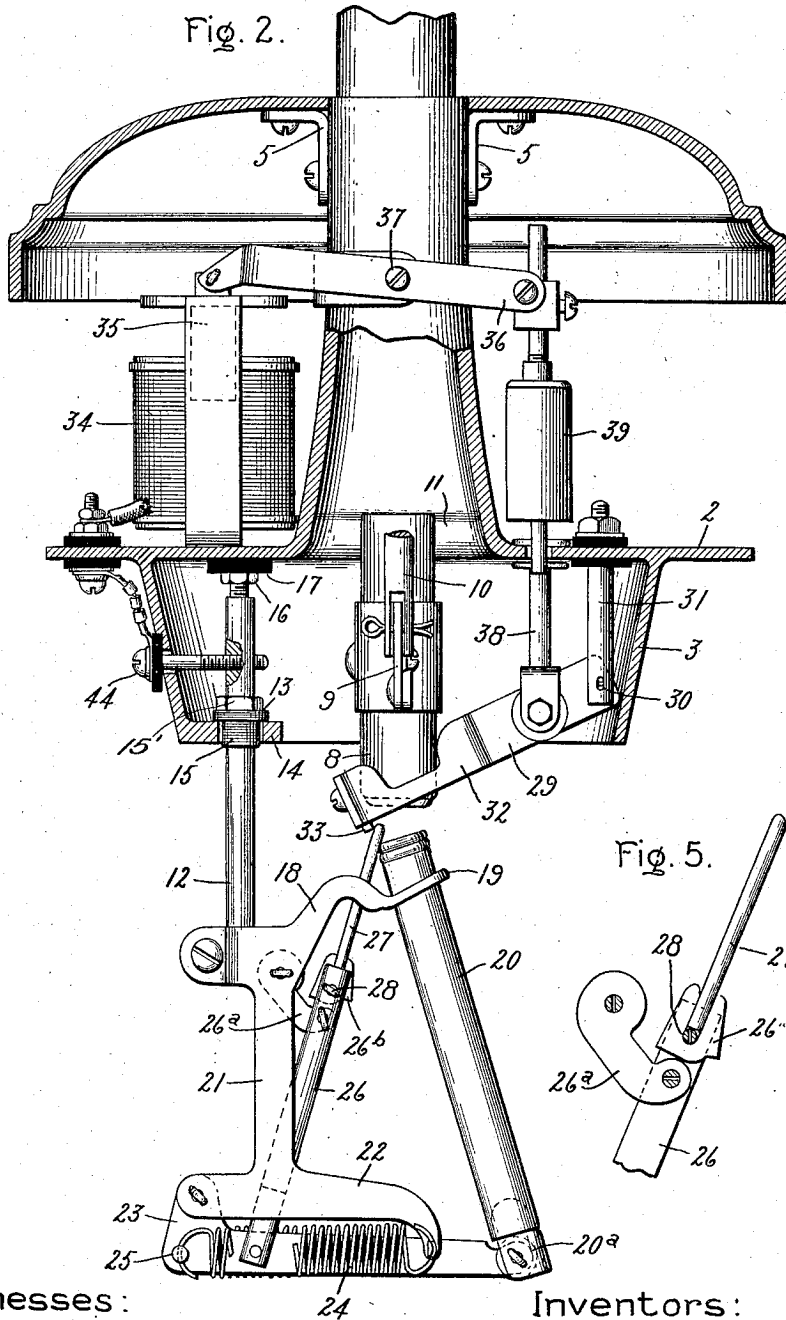


Fig. 5.

Witnesses:

*J. Earl Ryan*  
*J. Ellis*

Inventors:

Cromwell A. B. Halvorson, Jr.,  
John T. Beechlyn,  
by *Alfred Davi*  
Their Attorney.

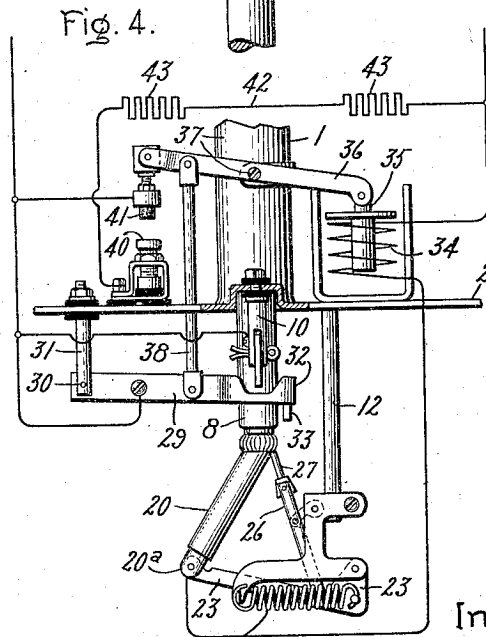
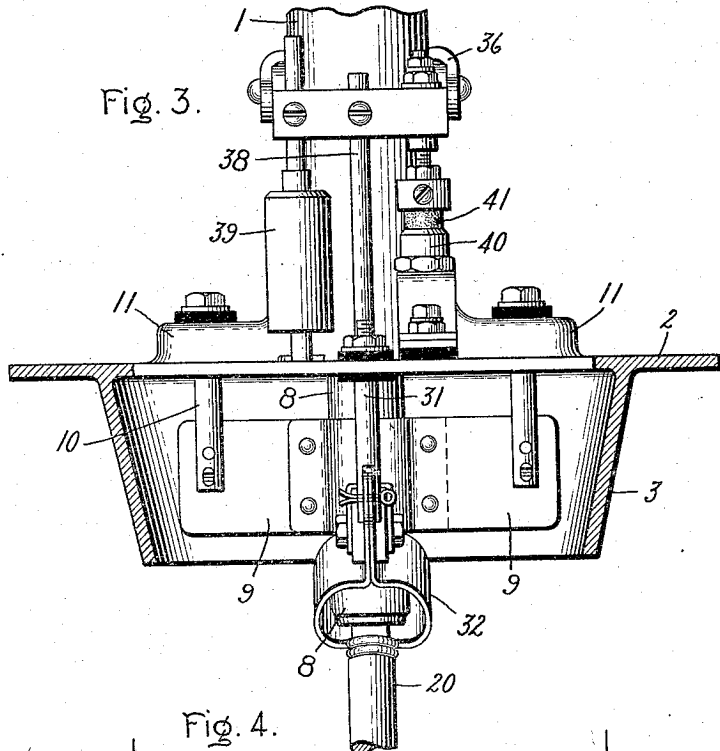
C. A. B. HALVORSON, JR. & J. T. BEECHLYN.  
ARC LAMP.

APPLICATION FILED APR. 3, 1912.

1,171,193.

Patented Feb. 8, 1916.

3 SHEETS—SHEET 3.



Witnesses:

*Carl G. Klock*

*J. Ellis Elin*

Inventors:

Cromwell A. B. Halvorson Jr.,

John T. Beechlyn,

by *Allan S. Davis*  
Their Attorney.

# UNITED STATES PATENT OFFICE.

CROMWELL A. B. HALVORSON, JR., OF SAUGUS, AND JOHN T. BEECHLYN, OF LYNN, MASSACHUSETTS, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC-LAMP.

1,171,193.

Specification of Letters Patent.

Patented Feb. 8, 1916.

Application filed April 3, 1912. Serial No. 688,180.

*To all whom it may concern:*

Be it known that we, CROMWELL A. B. HALVORSON, JR., and JOHN T. BEECHLYN, citizens of the United States, residing, respectively, at Saugus and at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Arc-Lamps, of which the following is a specification.

This invention relates to electric arc lamps, and especially to those of the luminous arc type.

The object of the invention is to provide a lamp which is simple in construction, durable in service and not liable to get out of order.

The features of novelty will appear from the following description and the appended claims.

In the accompanying drawings, Figure 1 is a perspective view of our improved lamp, with the outer casing removed; Fig. 2 is a sectional elevation of the working parts of the lamp on a larger scale; Fig. 3 is a sectional elevation taken at right angles to Fig. 2; Fig. 4 is a side elevation of a portion of the regulating mechanism with a diagram of the circuits of the lamp; and Fig. 5 is a sectional detail view.

The frame of the lamp comprises a central chimney 1 whose lower end is somewhat flaring and is provided with a circumferential horizontal flange 2 from which depends a circular wall 3, preferably sloping inward somewhat, as shown. A canopy 4 surrounds the chimney a suitable distance above the flange 2, and is attached to said chimney, as by means of the brackets 5. The canopy extends preferably beyond the periphery of the flange 2, to afford a support for the casing and globe holder, which are not shown in the drawings. To the upper end of the chimney is secured a spider 6, carrying the usual dead-eye 7 by means of which the lamp is suspended. The upper non-consuming electrode 8 is a massive stick of metal, preferably of copper, and is provided with laterally-projecting wings 9 which are secured to insulated hangers 10 depending from the flange 2. In order to give an unobstructed entrance to the chimney above these wings, the flange is preferably arched above them on each side of the chimney, as shown at 11. The lower consuming electrode is supported by a rod 12

which is provided with a nut 15' located immediately above a bushing 15. This bushing passes through an opening in a lug 14 which extends inwardly from the lower edge of the circular wall 3, and at its upper end the bushing is formed with a flange 13 which rests upon the lug 14. A jam screw 16 in the upper end of the rod 12 bears against a plate 17 of insulating material placed against the underside of the flange 2. The lower end of the rod carries a frame 18, which has a guide 19 for the lower electrode 20, and comprises also two depending legs 21, having feet 22. The upper end of the electrode shell is beaded to hold in position the usual metal disk which prevents the magnetite or other electrode mixture from falling out. Between the heels of the feet 22 is fulcrumed a lever 23, preferably L-shaped, with its long horizontal arm pivoted to a plate 20<sup>a</sup>, which is received in the lower end of the electrode 20. Tension springs 24 are attached to the toes of the feet 22 and to pins 25 at the angle of the L-shaped lever 23, so that said springs tend to lift the long arm of the lever and urge the electrode 20 upwardly. A member, which we have shown as comprising a rod or bar 26 to the upper end of which a pin 27 is secured, is pivoted to the lever 23, and abuts, at its upper end, against the electrode 20. The lower bifurcated end of the bar 26 receives the inner end of the horizontal arm of lever 23 and is pivoted thereto. The upper end of the bar 26, which is also bifurcated, is connected to the legs 21 by a link 26<sup>a</sup>, the outer end of which is pivoted between the prongs formed at the upper end of the member 26, and the inner end of which is pivoted between the legs 21. A flat piece 26<sup>b</sup>, provided with two upwardly directed jaws, as shown in Fig. 5, is secured at the upper end of the member 26 between its prongs by a cotter pin 28, and this member rests upon the outer end of the link 26<sup>a</sup>. A pin 27 of any suitable fusible material such as iron or steel is received between the upper prongs of the member 26 and between the two jaws of the member 26<sup>b</sup> which forms a support for said pin. The upper ends of the lower electrode 20 and of the pin 27 pass through the opening in the guide 19, and as they converge and are impelled upwardly by the springs 24 the pin 27 will be wedged against the upper end of the lower electrode 20, 110

The pin 27 is consumed, together with the lower electrode, but much more slowly, the ratio of consumption of the pin to that of the electrode corresponding to their respective rates of movement, and is renewed with the lower electrode when the lamp is trimmed. This pin 27 is, therefore, virtually an auxiliary electrode, although it is not relied upon for giving luminosity to the arc. It will thus be understood that the distance of the lower electrode from the upper one is kept constant, and the arcing face of the upwardly-feeding lower electrode remains stationary.

Inasmuch as both electrodes are stationary, so far as their tips are concerned, means must be provided for striking the arc. Moreover, in luminous arc lamps, a crust is liable to form on the end of the composition electrode when it cools, and as this is of high electrical resistance, means must also be provided for breaking this crust off when the lamp is started, in order to permit the current to flow freely. We accomplish both the breaking of the crust and the striking of the arc by means of a lever 29 fulcrumed at 30 within the wall 3, and preferably on an insulated pin 31 depending from the flange 2. The free end of the lever is a ring 32 encircling the upper electrode and carrying a finger 33 which comes in contact with the lower electrode 20 when the lever is dropped to the position shown in Fig. 2, the position it occupies when the lamp is out and when it is freshly trimmed, in which case the pin or auxiliary electrode projects slightly beyond the electrode proper. The arc is, therefore, initially started from the auxiliary electrode, which, however, quickly burns away to the level of the main electrode, so that at the subsequent startings, the lever 29 drops farther down, so that the finger 33 comes in contact with the end face of the main electrode. The lever drops suddenly to this position, and the blow of the finger on the end of the electrode 20 chips off any crust which may have formed there, so that said finger rests in good electrical contact with said electrode. The lever is electrically connected to the same side of the line as the upper electrode, so that when the current is turned on the circuit is at once established. The striking of the arc is effected by the electromagnet 34 whose movable core 35 is attached to one end of a beam 36, pivoted at 37 on the sides of the chimney, which said beam straddles. The other end of said beam is connected by a pitman 38 with the lever 29 at a point between the fulcrum 30 and the ring 32. When the lamp circuit is closed, the electromagnet pulls down its core and this causes the lever 29 to be lifted, drawing the finger 33 away from the lower electrode and establishing the arc, which at once shifts from said fin-

ger to the upper electrode. A dash-pot 39 is connected with one end of the beam and serves to retard the movements of the beam and the lever 29 in striking the arc, so that there is no danger of its being snapped out by too quick a motion of the finger. In the operation of certain types of flaming or luminous arc lamps, particularly the magnetic lamp, copious fumes are emitted from the arc and a flocculent deposit is formed about the upper electrode. The movement of the arm 29 removes substantially all of the deposit from the upper electrode. The beam 36 also serves to operate the automatic cut-out of the lamp, which consists of the two contacts 40, 41 located in a short circuit 42 across the lamp, containing suitable resistors 43. The contact 40 is stationary, while the other one is attached to the beam so that when the current is turned on this short circuit will be opened.

By referring to Fig. 4, it will be seen that one side of the line is connected to the contact 41 and also to the upper electrode 8 and the lever 29, while the other side of the line is connected to the other contact 40 through the resistors 43, and also to the electromagnet 34 and thence to the lower electrode; preferably by means of an insulated screw 44 passing through the wall 3 and tapped into the rod 12.

In a copending application, Serial No. 573,015, filed July 21, 1910, in the name of Cromwell A. B. Halvorson, Jr., is shown and claimed a combination of a lower electrode and an upper electrode with a member which embraces the upper electrode and removes therefrom any deposit that may have formed thereon, which member is provided with a pin which in its descent breaks through any slag that may have formed on the lower electrode and strikes the arc when the same is lifted from the lower electrode. We do not in this application claim such a combination, which is the sole invention of one of us, but only the lower electrode and the mechanism associated therewith for impelling the same upwardly.

It will be seen that this lamp is quite simple in construction, and that the electromagnet, dash-pot and cut-out are protected from the heat and fumes of the arc by the flange 2 and the wall 3; the fumes passing freely up the chimney which is directly above the arc whose stationary position is an advantage. The moving parts are few, and all are readily accessible for inspection or repair, and the lamp is compact and attractive in appearance.

What we claim as new and desire to secure by Letters Patent of the United States, is:—

1. In an arc lamp, a pivoted lever, an electrode, means for pivotally connecting said electrode to said lever, an auxiliary elec-

trode and a support for the same pivoted to said lever intermediate the pivot of the lever and the pivotal connection of the electrode, means for moving said lever, and  
 5 means including the pivotal connections of the electrode and of the auxiliary electrode support to said lever for guiding said electrode and said auxiliary electrode into abutting engagement throughout their consumption.  
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2. In an arc lamp, a pivoted lever, an electrode, means for pivotally connecting said electrode to said lever, a member pivoted to the lever intermediate the pivot of the  
 15 lever and the pivotal connection of said electrode, an auxiliary electrode carried by said member and having a different rate of consumption in the arc from the electrode, means for moving said lever, and means including the pivotal connections of the electrode and of the auxiliary electrode support to said member for guiding said electrode and said auxiliary electrode into abutting engagement throughout their consumption.  
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3. In an arc lamp, a member pivoted at one end, an electrode, means for pivotally connecting said electrode to said member, a metallic pin, means for pivotally connecting  
 30 said pin to said member intermediate its pivoted end and the pivotal connection of the electrode, means for moving said pivoted member, and means including the pivotal connections of the electrode and of the auxiliary electrode support to said member for guiding said electrode and said pin into abutting engagement throughout their consumption.  
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4. In an arc lamp, a pivoted member, an electrode, means for pivotally connecting  
 40 said electrode to said member, a pin, means for connecting said pin to said member intermediate its pivoted end and the pivotal

connection of said electrode, means including the pivotal connections of the electrode  
 45 and of the auxiliary electrode support to said member for guiding said electrode and said pin into abutting engagement throughout their consumption, and a spring for moving said pivoted member.  
 50

5. In an arc lamp, a member pivoted at one end, an electrode, means for pivotally connecting said electrode to said member, a pin, means for pivotally connecting said  
 55 pin to said member intermediate the pivoted end of the member and the pivotal connection of the electrode, a guide for maintaining said pin and said electrode in abutting engagement, and means for moving said pivoted member about its pivot, said pin and  
 60 electrode consuming in the same ratio as their respective rates of movement whereby said electrode and said pin are moved in accordance with their consumption and maintained in abutting engagement.  
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6. In an arc lamp, a pivoted member, an electrode, means for pivotally connecting  
 70 said electrode to said member, a bar pivoted to said member intermediate the electrode connection and its own pivot and provided with a pin adapted to abut against said electrode, a guide for maintaining said pin and said electrode in abutting engagement, and means for moving said pivoted member  
 75 about its pivot, said pin and electrode consuming in the same ratio as their respective rates of movement whereby the electrode and the pin are maintained in abutting engagement throughout their consumption.

In witness whereof, we have hereunto set  
 80 our hands this twentieth day of March, 1912.

CROMWELL A. B. HALVORSON, JR.

JOHN T. BEECHLYN.

Witnesses:

JOHN A. McMANUS, JR.,

ROBERT SHAND.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

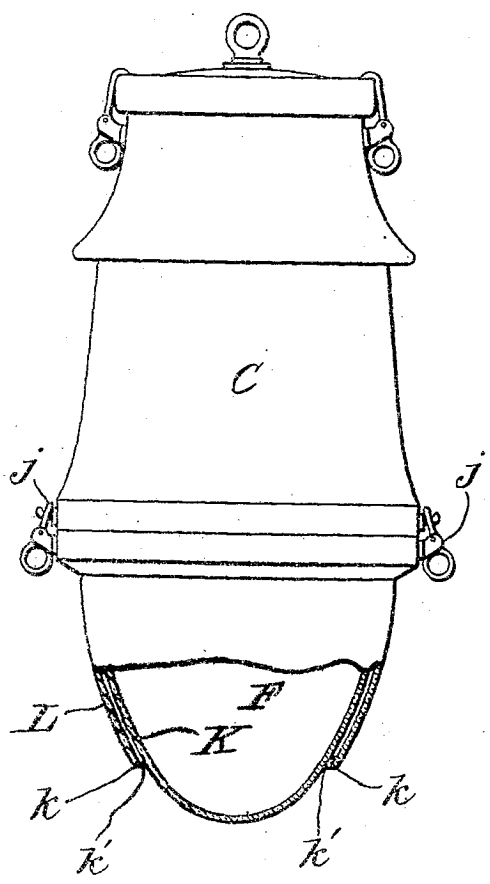
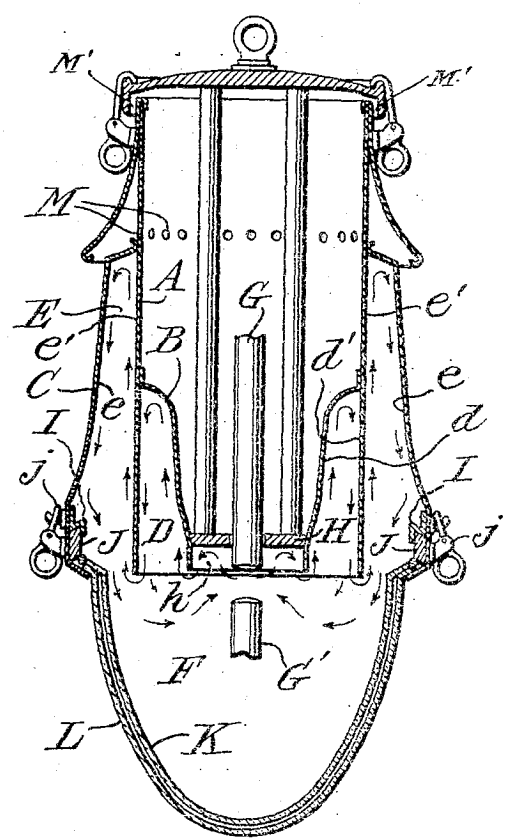
J. L. DINSMOOR.  
 ARC LAMP CONDENSER.  
 APPLICATION FILED MAY 8, 1914.

1,234,302.

Patented July 24, 1917.

*Fig. 1.*

*Fig. 2.*



WITNESSES

*A. C. Abbott*  
*M. C. Rodriguez*

INVENTOR

*John L. Dinsmoor*  
 BY *Edmond Bernhard*  
 ATTORNEYS



# UNITED STATES PATENT OFFICE.

JOHN L. DINSMOOR, OF BROOKLYN, NEW YORK.

## ARC-LAMP CONDENSER.

1,234,302.

Specification of Letters Patent.

Patented July 24, 1917.

Application filed May 8, 1914. Serial No. 837,133.

*To all whom it may concern:*

Be it known that I, JOHN L. DINSMOOR, a citizen of the United States, residing at the city of New York, borough of Brooklyn, county of Kings, and State of New York, have invented a certain new and useful Arc-Lamp Condenser, of which the following is a specification.

This invention is a condenser for arc lamps wherein the fine particles of dust mechanically suspended in gases evolved by the arc when burning chemically impregnated carbons, are eliminated from such gases in a thorough and efficient manner.

It is well established that an electric arc evolves certain gases which in the case of arc lamps carry fine particles of dust, the latter being set free when burning impregnated carbons. The gases thus evolved are desirably retained around the arc in order to perform the twofold function of obtaining luminous efficiency and of prolonging the life or service of the carbons, hence the necessity for replacing the carbons or trimming the lamp does not arise so frequently and the durability of the carbons is increased. The presence of the gases around the arc and within the globe inclosure brings about a very undesirable condition, *i. e.* the inner surface of the transparent globe becomes coated with a deposit of fine carbon dust, as a result of which the illumination afforded by the arc is materially interfered with and it is necessary to frequently clean the glassware by dismounting the globe and brushing out the accumulated dust.

Various attempts have been made in the art pertaining to arc lamps to overcome the foregoing objections, such as by the employment of different forms of globe inclosures, by filtration of the arc gases, and by the mechanical construction of condensing chambers; but so far as I am aware the problem of thoroughly eliminating the dust from the gases while retaining such gases around the arc and at the same time obtaining clean glass remains to a degree unsolved in long life lamps adapted for burning impregnated carbons.

The deposit of dust upon the interior surface of the globe was found to be due in an arc lamp minus a condenser to the circulation of the heated arc gases, carrying more or less dust, into contact with the relatively cooler surfaces of the globe around which the external air is free to circulate. It was

found, furthermore, that by keeping the globe around the arc in a hot condition, and by circulating the gases, laden with dust, into a chamber distinct from the arc chamber that a substantial amount of the dust was deposited upon the walls of such a separate chamber, due to the fact that the walls of such chamber were not heated so highly as the walls of the arc globe chamber, thus appreciably cooling the arc gases and resulting in a deposit of dust upon the relatively cooler walls of such separate chamber, the cooled and partly purified arc gases being free to flow back to the arc.

Condensers of the prior art are based upon a globe inclosure of a particular form, or a condensing chamber the cross sectional shape of which is such as to render it difficult to remove the deposits of carbon dust, or a globe inclosure which embodies an inner globe and an outer globe operating conjointly with an elevated condensing chamber so that the inner globe next to the arc is retained in a heated condition by said arc owing to the fact that the outer globe prevented the atmospheric air from coming into contact with said inner globe; but in all such prior art structures the condensing chamber was of such form and area that the arc gases were not so thoroughly purified as to wholly eliminate the carbon dust therefrom, as one result of which the globe inclosure became coated with carbon dust to a greater or less extent, dependent somewhat upon the character of the carbons and also upon the intervals of trimming the lamp.

The basic feature of the present invention is a condenser with a plurality of chambers each closed at the top and open at the bottom so that said chambers are in free communication at the bottom portions thereof with the globe inclosure, said chambers providing for the flow of arc gases successively from one to the other, whereby the gases from the arc are free to flow upwardly and downwardly within the chamber nearest the arc, so that the gases are measurably cooled by contact with the walls of said first chamber and some of the dust is deposited therein, after which the bases flow out of the first chamber, pass to a limited extent into the globe inclosure, and thence flow into the next chamber, within which last chamber the gases flow upwardly and downwardly so as to become again cooled

1,268,025.

G. M. LITTLE.  
ARC LAMP.  
APPLICATION FILED OCT. 3, 1913.

Patented May 28, 1918.  
2 SHEETS—SHEET 1.

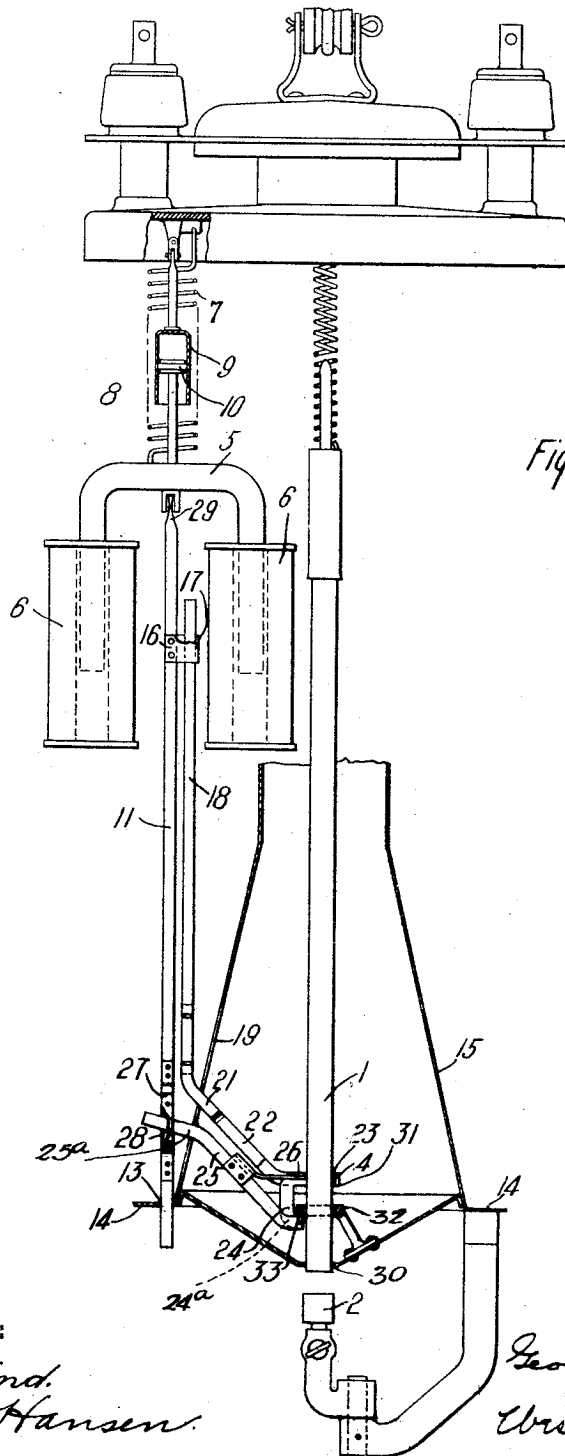


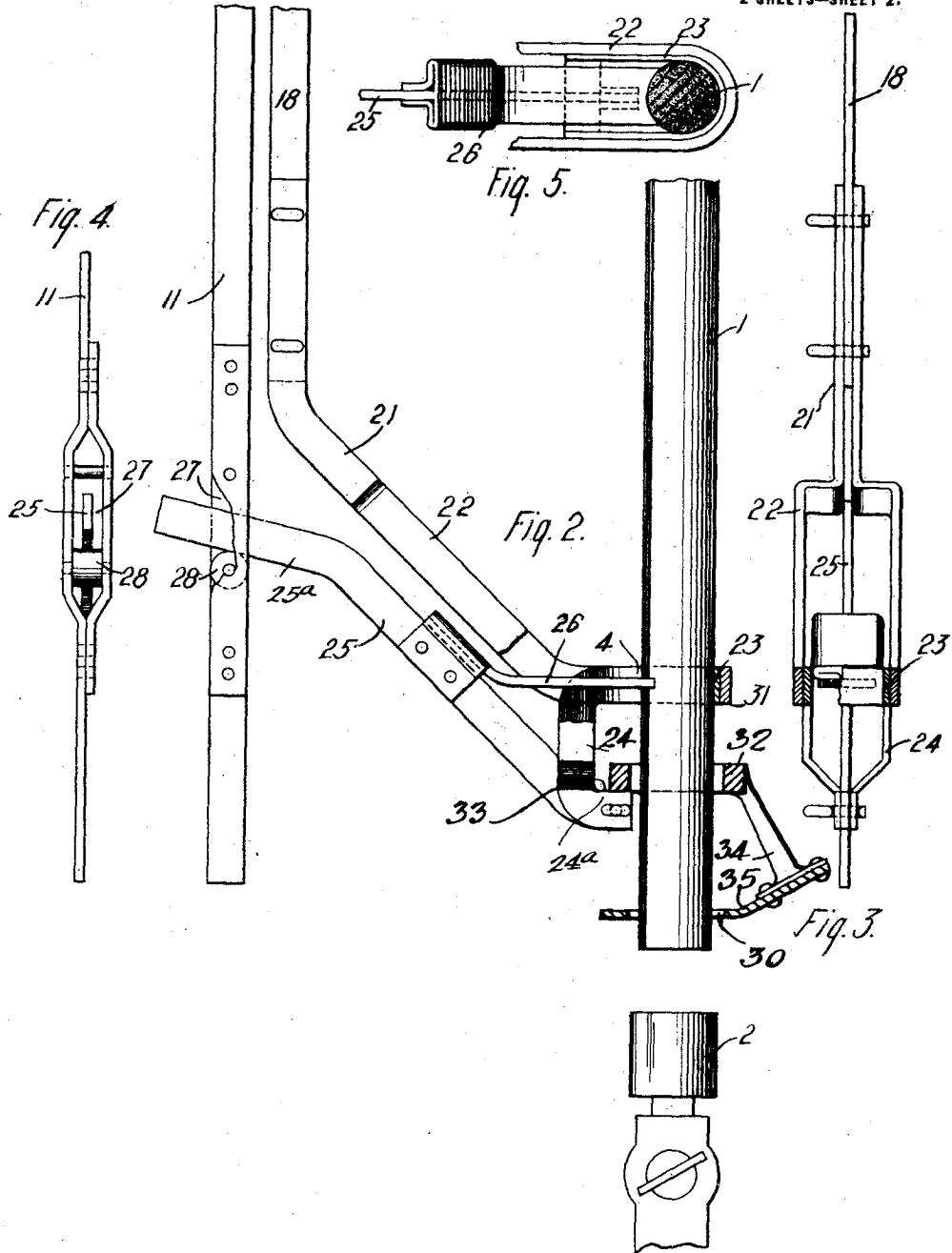
Fig. 1.

WITNESSES:  
*Fred. A. Lind.*  
*Geo. W. Hansen.*

INVENTOR  
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BY  
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1,268,025.

Patented May 28, 1918.  
2 SHEETS—SHEET 2.



WITNESSES:  
*Fred. A. Lind.*  
*Geo. W. Hansen.*

INVENTOR  
*George M. Little*  
BY  
*Wiley Carr*  
ATTORNEY

# UNITED STATES PATENT OFFICE.

GEORGE M. LITTLE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE  
ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## ARC-LAMP.

1,268,025.

Specification of Letters Patent.

Patented May 28, 1918.

Application filed October 3, 1913. Serial No. 793,111.

*To all whom it may concern:*

Be it known that I, GEORGE M. LITTLE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Arc-Lamps, of which the following is a specification.

My invention relates to arc lamps, and it has particular reference to improvements in supporting and guiding means for the movable electrodes of such lamps.

Consumable electrodes, as furnished by manufacturers, usually have slightly varying diameters and, as a result, such electrodes, when used in the usual electrode holders affect the satisfactory operation of arc lamps. One of the above mentioned operating defects exists when an upper electrode, having a smaller diameter than normal, is held too loosely by its clutch, which results in the tilting of the electrode and, consequently, in its binding against the wall of the aperture through which it projects into the arc chamber. Another unsatisfactory operating characteristic of an arc lamp equipped with a usual form of clutching means for the upper electrode is that the upper electrode may be held out of vertical alinement with the lower electrode, thus causing an unequal consumption of the arcing end of the electrode and, consequently, an unsteady arc and a flickering light, by reason of the tendency of the arc to creep up the sides of the upper electrode. This defect is exaggerated when the upper electrode is of short length at the end of the trim.

One object of my invention is to provide a mechanism for an arc lamp which will retain the upper electrode at all times in vertical alinement with the lower electrode.

Another object of my invention is to provide a mechanism for an arc lamp which may be adapted to effectively hold electrodes, having variations in their diameters, and which will draw the same length of arc at "pick up."

My invention is illustrated in the accompanying drawings in which Figure 1 is a side elevation, partially in section, of the principal operating parts of a lamp constructed in accordance with my invention; Fig. 2 is a partially sectional side elevation of a portion of the structure shown in Fig.

1; Fig. 3 is a front elevation of a clutching means embodying one form of my invention; Fig. 4 is a rear elevation of a portion of the device shown in Fig. 2, and Fig. 5 is a plan view of my electrode-engaging device.

Referring to the drawings, a movable upper electrode 1 coöperates with a lower stationary electrode 2 to maintain an arc between the opposing ends. Inasmuch as the lower electrode 2 is stationary, the arc-regulating functions and feeding operation of the lamp must be performed in connection with the upper electrode 1. A clutching mechanism comprising an engaging member 4, which embraces the electrode 1, is pivotally connected to an armature 5 of U-shape which co-acts with feeding coils 6.

While the lamp is inoperative, the electrodes 1 and 2 are held out of contact and in substantially the positions shown in Fig. 1. When the lamp is connected to the supply circuit, the feeding coils 6 becoming energized, pull down the armature 5 and permit the electrode 1 to move into electrical contact with the electrode 2. When current flows through the two engaged electrodes, the circuit, comprising the windings of the feeding coils 6, is opened (by means not shown in the drawing), thereby releasing the armature 5. By reason of a tensional element or spring 7, to which the armature is connected, the electrode 1 is drawn away from the electrode 2 and an arc is established, the length of the arc being determined definitely by mechanical engagement between certain of the parts of my device, such mechanical engagement serving to limit the upward movement of the armature 5 and its associated parts. A dash pot 8, comprising a cylinder 9 and a piston member 10, is preferably inserted between the spring 7 and the armature 5, thereby preventing a too rapid separation of the electrodes when the coils 6 become de-energized.

A main supporting rod 11, which is suspended from the armature 5, extends through a guiding aperture 13 formed in the outwardly flanged portion 14 of a draft tube casing 15. The rod 11 is adjusted in parallelism relative to the axis of the upper electrode 1 by the proper positioning of the aperture 13 through which the lower portion of the rod 11 projects.

Upon the upper portion of the rod 11 is rigidly secured a sleeve 16 having an outwardly extending portion 17 that loosely embraces an auxiliary rod 18, to serve as a guide therefor.

Projecting through an opening 19 in the wall of the draft tube 15 and rigidly secured to the rod 18, is a member 21, of U-shape comprising two arms 22 that are spaced apart to permit insertion of the electrode 1 and to constitute the embracing member 4, substantially as shown in the drawing. A member 23, attached to the adjacent inner faces of the two arms 22 and formed to engage the electrode 1, terminates in a downwardly extending bifurcated portion 24 to which is pivotally secured an inclined lever member 25. The portion 24 is provided with an inward projection 24<sup>a</sup> having a horizontal surface 33. A gripping device 26 is rigidly connected to the member 25 and is shaped to extend in a substantially horizontal direction, when in operative position, as shown in Fig. 2, in which position the members 26 and 4 cooperate as an electrode clutch. The inner end of the device 26 is curved inwardly to conform to the contour of the electrode 1 during engagement therewith, the edge of the device being sufficiently sharp to firmly grip the electrode. For a view of the member 4 engaging the electrode 1, reference may be had to Fig. 5. The lower end of the supporting rod 11 is provided with a longitudinally extending slot 27 which is bridged by a bearing roller 28. The free end 25<sup>a</sup> of the member 25 is supported upon and movably engages said bearing roller, substantially as shown.

With the upper electrode 1 in its raised position, a portion of its weight is transmitted by the rod 18 to the sleeve 16 which tends to cause the main supporting rod 11 to turn about its suspension point 29 to the left, as shown in Fig. 1, but the rod 11 is prevented from moving laterally by reason of the engagement of its lower end with the wall of the aperture 13. The vertical force exerted by the roller 28 against the member 25 causes the gripping member 26 to tend to rotate in a clockwise direction about the point at which it engages the electrode 1, and, consequently, the portion 24<sup>a</sup> tends to rotate about the same point and in the same direction. This causes the rod 18, by reason of its rigid relation to the portion 24<sup>a</sup>, to tend to move away from the rod 11, but, in which tendency it is restricted to a limiting position in parallel with the rod 11 by the sleeve 16. There is thus a binding relation between the parts, so long as any weight of electrode exists, that maintains the rods 11 and 18 and the electrode 1 in parallel relation. This eliminates the tendency of the electrode to bind against the walls of an aperture 30 through which it projects into the arc cham-

ber. In addition, the prevention of the binding of the electrode 1 in the aperture 30, and the assurance that the electrode 1 will burn evenly cooperate to insure satisfactory operation of an arc lamp embodying my invention. Electrodes having different diameters will be held firmly by the clutching mechanism, the rotation of the member 25 around its pivotal point of attachment to the member 24 serving to press the grip 26 against the engaged surface of the electrode before the upward movement of the electrode begins, irrespective of the diameter of the electrode.

The electrode 1 is intermittently fed, as in the usual type of arc lamps, and, in order that it may be released by the clutch to permit it to feed into the arc, the armature 5 is drawn downwardly by energization of the coils 6. A surface 31 of the clutch member 4 engages a stationary trip 32. The trip 32 is disposed intermediate the projection 24<sup>a</sup> and the clutch member and is rigidly supported by a bracket 34 to a lower wall 35 of the draft tube casing 15.

Engagement of the clutch member 4 and the trip 32 disengages the gripping member 26 from the electrode 1 permitting the latter to fall into contact with the lower electrode 2, thus causing current to flow between the electrodes. This permits the armature 5 to rise to its normal position, carrying with it the rod 11, and tilting the member 25 around its pivot to grasp the electrode. When the electrode is grasped between the members 26 and 23, the electrode and the clutch member 4 begin an upward movement that is continued until the surface 33 of the clutch engages, the underside of the trip 32. When the coils 6 are deenergized, the magnetic pull exerted upon the armature 5 is discontinued thereby permitting the spring element 7 to draw the armature 5 and the clutch mechanism attached thereto upwardly. Since the pull exerted by the spring element 7, at all times, tends to draw the armature upwardly a distance in excess of the proposed length of the arc in addition to a length adequately compensating for the play between the cooperating elements, the surface 33 of the projection 24<sup>a</sup> will always effect contact with the lower surface of the trip member 32 when the armature 5 is released from the pull of the coils 6. In this position, the gripping member firmly grips the electrode by reason of the pull exerted by the spring 7. By reason of the trip member being stationary, the "pull up" of the lamp is substantially the same, thus insuring the production, at all times, of an arc of substantially uniform length with commercial electrodes.

While I have shown and described a particular form of my invention, many changes may be effected therein without departing

from the spirit and scope of the same, as set forth in the appended claims.

I claim as my invention:

5 1. An arc lamp comprising a central draft tube provided with a lateral opening, a movable electrode positioned in said draft tube, an exterior main supporting rod, guiding means therefor, means for moving said rod longitudinally of said electrode, and a mechanism supported by said main rod that projects through the lateral opening in said draft tube to engage said electrode and impart motion thereto that is transmitted from said main rod.

15 2. An arc lamp comprising a central draft tube provided with a lateral opening, a movable electrode positioned in said draft tube, an exterior main supporting rod, guiding means therefor, means for moving said rod longitudinally of said electrode, a mechanism supported by said main rod that projects through the lateral opening in said draft tube to engage said electrode and impart motion thereto that is transmitted from said main rod, and means for limiting the upward travel of said electrode when engaged by the said mechanism.

30 3. An arc lamp comprising a central draft tube provided with a lateral opening, a movable electrode positioned in said draft tube, an exterior main supporting rod, that is constrained to move longitudinally, means for imparting motion to said main rod, and a mechanism that is supported by said main rod exteriorly of the draft tube and projects through the lateral opening in the draft tube to grip said electrode, whereby the motion of the main rod may be transmitted to the electrode engaged by the said mechanism.

4. In an arc lamp, the combination with a movable electrode, of a clutch mechanism therefor comprising a main rod that is constrained to move longitudinally of said electrode, an electrode-engaging member supported by said main rod, an inclined lever member pivotally connected at one end to said electrode-engaging member and slidably engaging said main rod and a gripping member attached to said inclined lever member for gripping said electrode when said main rod is moved upwardly, and a tripping mechanism for releasing the electrode when the said clutch mechanism is moved downwardly in excess of a predetermined amount.

5. In an arc lamp, the combination with a movable electrode, of a clutch mechanism therefor comprising a main rod that is constrained to move longitudinally of said electrode, an electrode-engaging member supported by said main rod, an inclined lever member pivotally connected at one end to said electrode-engaging member and slidably engaging said main rod, a gripping member attached to said inclined lever member, and means for effecting a firm gripping action between said electrode and the gripping member when the former is moved upwardly a predetermined amount and for releasing said electrode from the gripping member when the electrode is moved downwardly a predetermined amount.

In testimony whereof, I have hereunto subscribed my name this 26th day of Sept., 1913.

GEORGE M. LITTLE.

Witnesses:

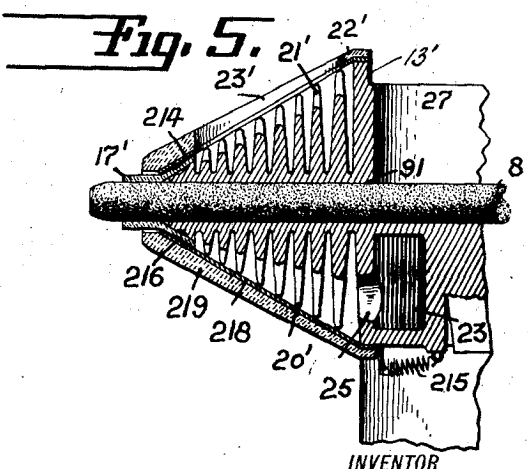
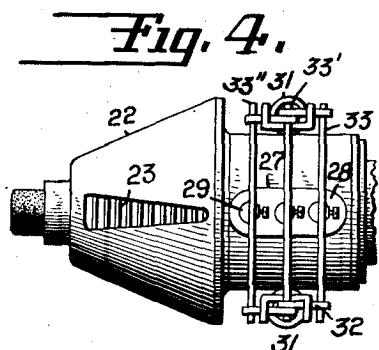
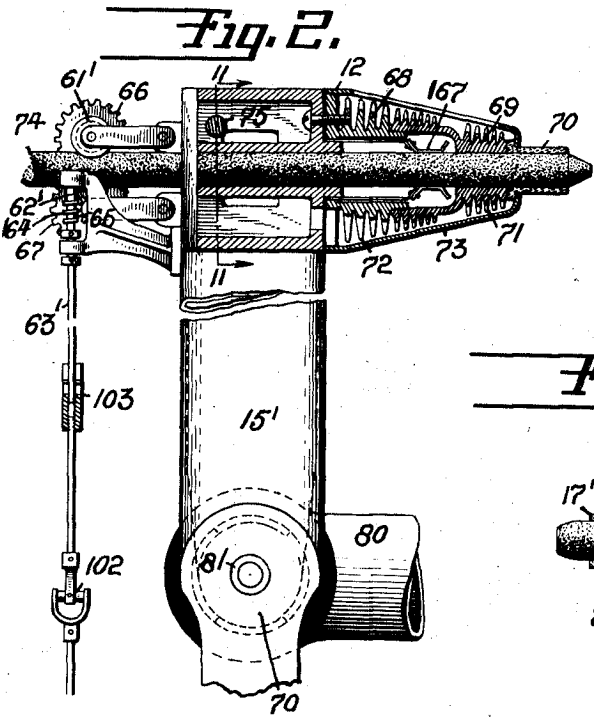
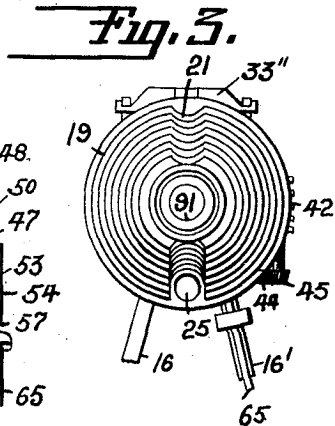
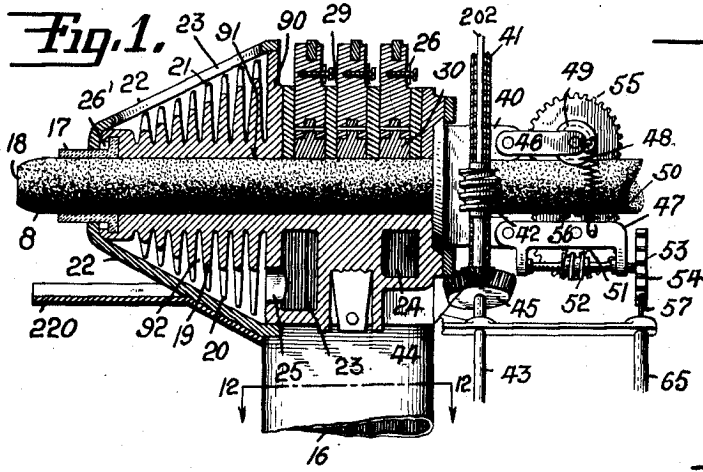
B. B. HINES,  
M. C. MERZ.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

E. A. SPERRY,  
 ELECTRODE HOLDER FOR SEARCH LIGHTS.  
 APPLICATION FILED MAR. 13, 1918.

1,282,133.

Patented Oct. 22, 1918.  
 3 SHEETS—SHEET 1.

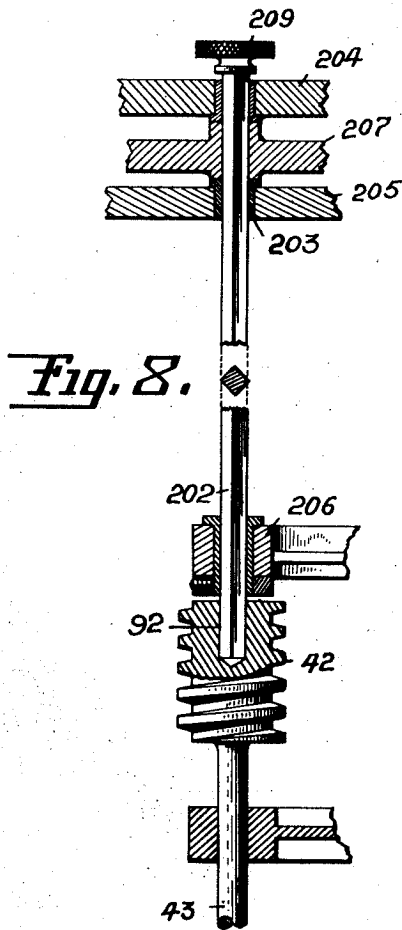


INVENTOR  
 EIMER A. SPERRY.  
 BY  
 Herbert A. Thompson  
 ATTORNEY

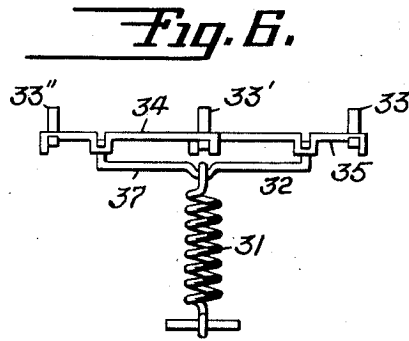
E. A. SPERRY.  
ELECTRODE HOLDER FOR SEARCH LIGHTS.  
APPLICATION FILED MAR. 13, 1918.

1,282,133.

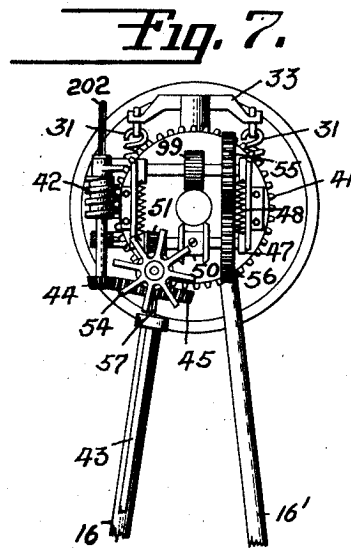
Patented Oct. 22, 1918.  
3 SHEETS—SHEET 2.



*Fig. 8.*



*Fig. 6.*



*Fig. 7.*

INVENTOR

ELMER A. SPERRY.  
BY  
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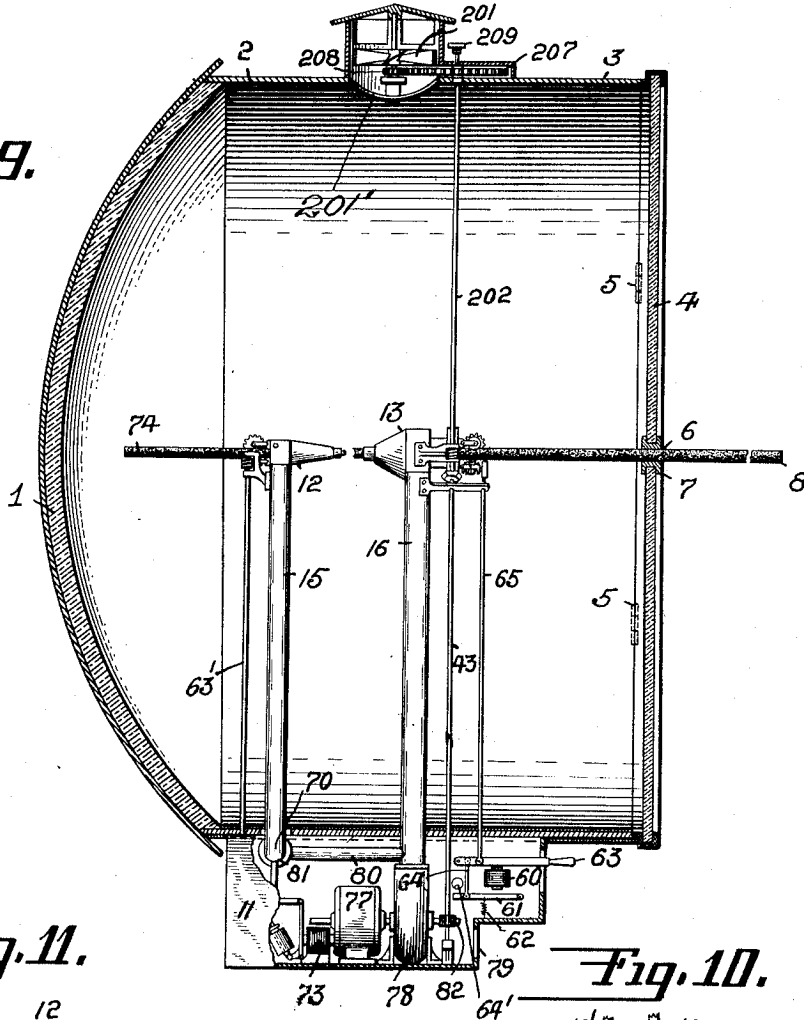


E. A. SPERRY.  
ELECTRODE HOLDER FOR SEARCH LIGHTS.  
APPLICATION FILED MAR. 13, 1918.

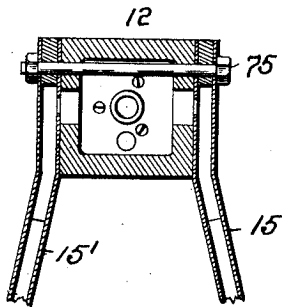
1,282,133.

Patented Oct. 22, 1918.  
3 SHEETS—SHEET 3.

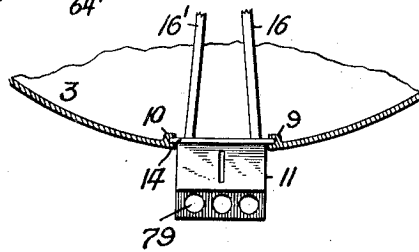
*Fig. 9.*



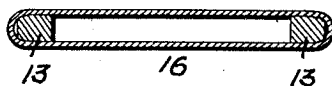
*Fig. 11.*



*Fig. 10.*



*Fig. 12.*



INVENTOR

ELMER A SPERRY

BY  
*Herbert H. Thompson*  
ATTORNEY

# UNITED STATES PATENT OFFICE.

ELMER A. SPERRY, OF BROOKLYN, NEW YORK.

## ELECTRODE-HOLDER FOR SEARCH-LIGHTS.

1,282,133.

Specification of Letters Patent.

Patented Oct. 22, 1918.

Original application filed April 16, 1915, Serial No. 21,661. Divided and this application filed March 13, 1918. Serial No. 222,208.

*To all whom it may concern:*

Be it known that I, ELMER A. SPERRY, a citizen of the United States of America, residing at 1505 Albermarle road, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electrode-Holders for Search-Lights, of which the following is a specification.

This invention relates to high power search-lights, its object being to improve the method of operating the electrodes and the apparatus therefor so that a greatly increased candle-powder is obtained. While I propose to use in my searchlight the very latest developments in arc-sustaining and light emitting materials, such as thin, cored, flaming arc carbons, my invention does not lie in the electrodes *per se* but in the combination of such electrodes with my improved apparatus for burning the same.

For operating the electrodes of search-lights at the high current density and with the heavy currents which I propose to use, I have found the existing types of holders and other mechanical features of the standard searchlight utterly unsuited. The main object of my invention is to devise a practicable means by which the heavy current is handled within the lamp without loss or damage to the electrodes and whereby the operating conditions of the arc are improved, so that continuous, efficient burning may be secured. I have found that the principal causes of lack of brilliancy and loss of candle power in such lights are first, the loss of the heat of the crater by conduction and radiation; second, the vaporization and oxidation of the carbon farther back of the crater of the positive carbon than a predetermined amount; third, loss of electrical energy through the resistance of the carbon, and fourth, the spreading of the arc to the sides of the carbon, which is for the most part due to said vaporization and oxidation. For searchlights, the only effective light is that which issues from the crater itself or the immediate vicinity thereof. In other words, high intrinsic brilliancy at the crater is the condition most desired. The intrinsic brilliancy may be said to depend on at least four important factors—first, the electrical energy supplied to the electrode; second, the reduction of the loss due to electrical resistance within the electrode; third, the confin-

ing of the arc to the immediate vicinity of the crater, and fourth, the elimination as far as possible of the loss of heat energy due to conduction of heat back through the electrode.

It is not often realized that of the energy converted to heat at the crater only 40% is radiated (as crater emanations) from the crater as heat and light, while the remaining 60% is lost by conduction back through the carbon whence it is dissipated at lower temperature by heat radiation and convection due to air currents. It is the purpose of this invention to increase the per cent. of the energy converted into useful radiations at the crater, to decrease the conduction and convection losses and to reduce arcing from the sides of the electrode, thus materially increasing the intrinsic brilliancy. To accomplish this I run the positive carbon at high current density, surround it for some distance back of the crater with a refractory sleeve adapted to shield or insulate the electrode from air currents, and introduce current close to the arc which last is rendered possible by cooling the electrode between the point of current introduction and said sleeve. The sleeve need not and preferably does not, however, extend to the end of the electrode but stops a short distance from it so that a limited but very desirable spindling of the electrode may take place.

According to the preferred form of my invention the said sleeve, the cooling means and the current introducing means all form a part of the electrode holder, within which the electrode is both fed and rotated.

Another object of my invention is to improve the general construction of search-lights. Further objects will appear as the invention is described in detail.

In the drawings in which are illustrated several forms that the invention may assume:

Figure 1 is a sectional elevation of the holder for the positive electrode;

Fig. 2 is a corresponding sectional elevation of the negative holder;

Fig. 3 is a front view on a smaller scale of the positive electrode holder with the outer covering or shield removed;

Fig. 4 is a plan view on a reduced scale of the positive holder;

Fig. 5 is a sectional elevation of a modified form of electrode holder;

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Fig. 6 is a detail showing the method of applying pressure to the brushes in the positive holder;

Fig. 7 is a rear elevation of the positive holder;

Fig. 8 is a detail thereof;

Fig. 9 is an elevation of the interior of the searchlight drum;

Fig. 10 is a detail showing the manner in which the box supporting the lamp mechanism is supported within the drum;

Fig. 11 is a section on line 11—11 of Fig. 2;

Fig. 12 is a cross section of one of the standards supporting the holders, on line 12—12, Fig. 1.

In Fig. 9, 1 represents the reflector or projector of the searchlight 2, while the drum is shown at 3 and the front window at 4. The front window is preferably made so that it may be swung open on hinges 5 or may otherwise be removed to permit the withdrawing of the lamp mechanism. The window is shown as provided with an opening 6 near the center thereof which is reinforced by a thimble 7 through which the positive electrode 8 may project and which serves to support the outer end of the electrode. The drum is preferably provided with guideways 9 and 10 adjacent the bottom thereof. In these guideways the control box 11 which supports the electrode holders 12 and 13 is adapted to slide. For this purpose the box is shown as provided with flanges 14 which fit into said guideways. It will readily be seen that by opening the front door the control box together with the electrode holders may be readily removed. While in Fig. 9 the holders are shown as axially positioned, this arrangement may be obviously varied within fairly wide limits without affecting the operation of the invention described and claimed herein.

Instead of securing the electrodes to their holders and moving the holders bodily to effect the feeding of the electrodes, as has heretofore been the standard practice in searchlights, I prefer to make at least one and preferably both holders stationary during the normal burning of the arc and to feed the electrodes through their holders and also to rotate at least one of the electrodes within the holder.

The holders 12 and 13 for the electrodes are preferably supported from the control box 11 on hollow legs or standards 15 and 16 which preferably also serve to introduce a supply of cooling fluid to the holders, as hereinafter described, and to lead in current to the electrodes. Pairs of standards 15 and 15' and 16 and 16' are shown as provided for each holder. The holder 13 preferably comprises a metallic body portion 90 which is secured to the upper ends of the legs 16 and 16'. The said holder is provided with

an axial bore 91 for the electrode and serves to perform a variety of functions. Adjacent the forward end thereof is secured a refractory heat-resisting sleeve 17 adapted to insulate or shield the electrode from the air. Said sleeve is preferably made of quartz or the like and is shown as extending fairly close to the arcing face 18 of the electrode, but spaced a predetermined distance therefrom. The sleeve preferably forms an extension from the holder, being clamped thereto at its forward end, as hereinafter explained. This sleeve performs several important functions, among which is that it maintains that portion of the electrode which it surrounds at white incandescence by reducing radiation and shielding it from heat abstracting air currents. It also shields the electrode from vaporization and oxidation, which at this temperature would cause too great spindling of the electrode. The metallic holder also assists in performing the last named function, being joined to the sleeve. The action of the arc flame and heat on the projecting portion of the electrode is to cause it to taper to a more or less degree and hence to reduce the size of the light source, or in other words, the size of the positive crater. As is well known in searchlights, the smaller the light source secured the greater the intensity and brilliancy of the beam, so that by permitting this predetermined tapering to occur the size of the light source is appreciably reduced and the efficiency of the light increased for a given size of the positive electrode. By feeding the electrode through the holder, the length of the tapering section is kept constant, while the rotation of the electrode causes equal spindling on all sides.

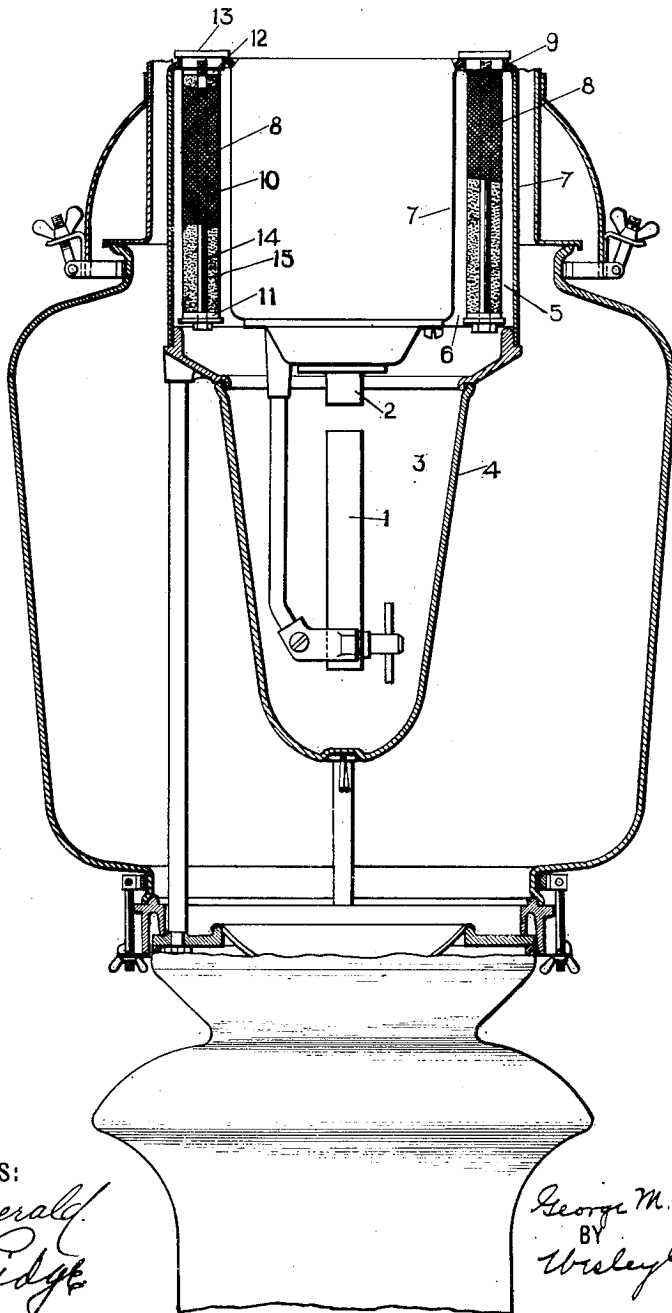
As above remarked, however, only a comparatively slight spindling is allowed to take place, *i. e.*, the crater area should not be materially less than 80% of the cross sectional area. As the loss of heat from a crater by conduction depends on the cross-section of the carbon, and as in ordinary arcs such great spindling takes place that it is necessary to employ an electrode of at least twice the size of the crater, it will be seen that the sleeve permits me to reduce conduction losses by employing a small electrode.

Back of the sleeve the holder is formed in such manner as to permit the circulation therethrough or thereover of a cooling fluid such as air and to dissipate heat at a rapid rate thereto. For this purpose the holder is shown as provided with a plurality of heat-radiating fins or ribs 19 having cut-away portions 20—21 adjacent their tops and bottoms to permit the free intake and egress of the air. The holder preferably tapers toward the arc. The ribs so provided are preferably entirely inclosed by an outer member

G. M. LITTLE.  
ARC LAMP.  
APPLICATION FILED OCT. 3, 1913.

1,284,387.

Patented Nov. 12, 1918.



WITNESSES:  
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*Wiley S. Carr*  
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# UNITED STATES PATENT OFFICE.

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## ARC-LAMP.

1,284,387.

Specification of Letters Patent. Patented Nov. 12, 1918.

Application filed October 3, 1913. Serial No. 793,113.

*To all whom it may concern:*

Be it known that I, GEORGE M. LITTLE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Arc-Lamps, of which the following is a specification.

My invention relates to electric lighting, and it has particular reference to improvements in luminous and flaming arc lamps.

Electrodes which are burned in arc lamps are composed of various substances in combination with carbon, which is the principal constituent. This association of certain substances with carbon imparts to the resulting arc the so-called flaming characteristics. When the electrodes are impregnated with light-giving ingredients only, the resultant arc is very unstable. It has been found, however, that, by the introduction of fluorin, preferably in chemical combination with light-giving minerals, the arc is strengthened and its stability is greatly increased. Consequently, all commercial electrodes adapted for use in flaming or luminous arc lamps have fluorin as a constituent, which is usually in the form of a chemical combination with a light-giving material.

As a result of the introduction of fluorin into the body of the electrodes, hydrofluoric vapors or fumes are generated as the electrodes are consumed, thus causing the etching of the glass arc-inclosing globe. To eliminate this difficulty, an absorbent material, preferably calcium carbonate or magnesium carbonate, is placed in the condensing chamber for absorbing the hydrofluoric vapors and thus preventing the etching of the glass walls of the arc globe through which the light emitted from the arc must necessarily pass.

One object of my invention is to provide, in an arc lamp of the character indicated above, a novel means for introducing the aforementioned absorbing material into the condensing chamber.

Another object of my invention is to provide means whereby the absorbent material may be most effectively and efficiently utilized in absorbing the hydrofluoric vapors generated during the consumption of the impregnated electrodes.

A further object of my invention is to provide means for easily replacing absorbent material which has lost its effectiveness by new material to further absorb hydrofluoric fumes and vapors.

Other features of novelty will be disclosed in the following description and in the accompanying drawing in which I have illustrated one practical embodiment of my invention, but the construction shown therein is to be understood as illustrative only, and not as defining the limits of my invention.

In the drawing, the single figure is a side view, partially in section, of a portion of an arc lamp constructed in accordance with my invention.

Referring to the drawing, the flaming arc extends between the opposing and adjacent ends of a lower electrode 1 and an upper electrode 2, both of said electrodes being impregnated with light-giving minerals by means of which the flaming arc is produced. To insure stability to the arc, fluorin, preferably in chemical combination with one of the light-giving minerals, has previously been added. As the electrodes 1 and 2 are consumed in the arc, hydrofluoric vapors or fumes are emitted therefrom which collect in the arc chamber 3 within the globe 4, said globe being closed to preclude the admission thereto of atmospheric air. Because the walls of the globe 4 are maintained hot during the existence of the arc, the hydrofluoric vapors, instead of being condensed and deposited thereon, rise and pass, with the other gases emitted from the arc, into an annularly shaped cooling or condensing chamber 5 which is positioned above the arc chamber 3 and in free communication therewith by means of an annular passage way 6, substantially as shown in the drawing. Some of the gases and vapors from the arc chamber come into contact with cool walls 7 which inclose the condensing chamber 5 and are condensed and deposited in the form of a fine powder.

In order to effectively absorb the hydrofluoric vapors which collect in the condensing chamber 5, I provide one or more consumers 8 and suspend the same from an upper inclosing wall 9 to extend downwardly into the condensing chamber 5. I prefer to use a plurality of consumers 8 in each lamp, and I prefer also that they be positioned at equal intervals and be

spaced from the side walls 7 of the chamber 5, as shown in the drawing. A consumer 8 is preferably made in the form of an upright prism or cylinder comprising a cylindrical shell 10 made of metallic mesh or wire gauze such, for example, as iron gauze. The bottom of each shell 10 is provided with a disk 11, and its top is provided with a disk 12 and with a plug 13. The shell is clamped between the disk 11 and the plug 13 by a rod 14 having a head to engage the disk and a threaded end to screw into the plug.

To charge the consumer 8, absorbent material 15, as, for example, calcium carbonate, is placed in a shell 10 in the form of a coarse powder. The threaded end of the rod 14 is then screwed in the plug 13 which is attached to the wall 9 in any well-known and suitable manner to provide a tight joint.

The cylindrical shell 10, containing the absorbing material 15 in the form of a coarse powder, may be replaced by a molded composition prism or hollow cylinder. This form of consumer will eliminate the use of the gauze shell 10, but the absorbing qualities of the consumer may be considerably decreased by reason of the limited amount of the absorbing material which is exposed to the gases contained within the condensing chamber 5.

When all the consumers are positioned in the condensing chamber 5, the said chamber is closed to preclude the inflow of atmospheric air and the outflow of arc gases. The hydrofluoric vapors coming from the arc chamber 3 are absorbed by the calcium carbonate material 15 which thus prevents them from etching the inner surfaces of the inclosing globe 4. It will be apparent that the consumers 8 are formed to present a maximum surface of absorbing material to the gases circulating or collecting within the condensing chamber 5, by inclosing the said material within a wire gauze or screen cylinder which retains the said material within the consumer while, at the same time, placing it in intimate contact with the arc gases. Moreover, the consumers 8 are placed intermediate the walls 7 of the condenser so as to have all of the sides of the consumers exposed to the gases contained in the condenser. Again, when recharging is necessary, the consumers 8 may readily be removed from the condensing chamber 5 by detaching the plugs 13 from the wall 9. Consequently, the charging operation is quickly and expeditiously performed without requiring much time or skill.

While I have particularly described a flaming arc lamp having a condensing chamber which is provided with vertically extending cooling walls, I do not wish to be understood as limiting my invention to such a disclosure, as it will be apparent to any one

skilled in the art that modifications may be made without departing from the spirit and scope of my invention.

I claim as my invention:

1. In an arc lamp, an arc-inclosing globe closed at its bottom, a cooling chamber positioned above the said globe and closed to preclude the inflow of air and the outflow of arc gases, and an exteriorly removable consumer positioned in said cooling chamber.

2. In an arc lamp, an arc-inclosing globe open at its upper end, a superimposed substantially air-tight heat radiating chamber having an opening registering with the globe opening, and an exteriorly removable consumer positioned in said heat-radiating chamber, whereby vapors and fumes collecting therein may be absorbed.

3. In an arc lamp, an arc-inclosing globe closed at its bottom and having walls of transparent or translucent material which is susceptible to deterioration by reason of fumes and vapors emitted from the arc, a condensing chamber closed to preclude the inflow of air and the outflow of arc gases and freely communicating with the chamber of the arc inclosing globe, and a plurality of exteriorly removable consumers serving to absorb fumes and vapors emitted from the arc.

4. In an arc lamp, an arc-inclosing globe, a cooling chamber having communication therewith, whereby the heated gases and vapors emitted from the arc are free to flow therein, a consumer positioned in said cooling chamber, and means for exteriorly removing said consumer.

5. In an arc lamp, an arc inclosing globe, a cooling chamber positioned above said globe and in communication therewith, said cooling chamber being closed against the circulation therethrough of atmospheric air, and an exteriorly removable consumer positioned in the cooling chamber, said consumer comprising a perforated shell, a charge of gas-absorbing material, and a means for recharging said shell.

6. In an arc lamp, an arc-inclosing globe, a cooling chamber communicating therewith into which the heated gases and vapors emitted from the arc are free to flow, and an exteriorly removable consumer positioned in said cooling chamber, said consumer comprising a perforated shell surrounding a charge of gas-absorbing material, and a solid plug to which said shell is attached, whereby the said cooling chamber may be closed to preclude the admission of atmospheric air when the consumer is in operative position.

7. In an arc lamp, an inclosing globe, an annular shaped cooling chamber communicating therewith and positioned to admit the flow therein of gases and vapors emitted from the arc, and a plurality of equally spaced and exteriorly removable consumers

spaced intermediate the walls of the cooling chamber, each consumer comprising a perforated shell surrounding a charge of gas absorbing material, a means for recharging  
5 said shell, and a supporting plug adapted to preclude the admission of atmospheric air to the said cooling chamber.

8. In an arc lamp, an inclosing globe, a closed cooling chamber extending annularly  
10 above and beyond the said globe and communicating therewith, and a plurality of

elongated consumer units vertically disposed in the said cooling chamber and severally secured to plugs disposed in openings in the outer wall of the said cooling chamber.

In testimony whereof, I have hereunto  
subscribed my name this 26th day of Sept.,  
1913.

GEORGE M. LITTLE.

Witnesses:

B. B. HINES,  
M. C. MERZ.

E. A. SPERRY,  
 FEEDING MECHANISM FOR SEARCHLIGHTS.  
 APPLICATION FILED FEB. 7, 1917.

1,362,575.

Patented Dec. 14, 1920.

4 SHEETS—SHEET 1.

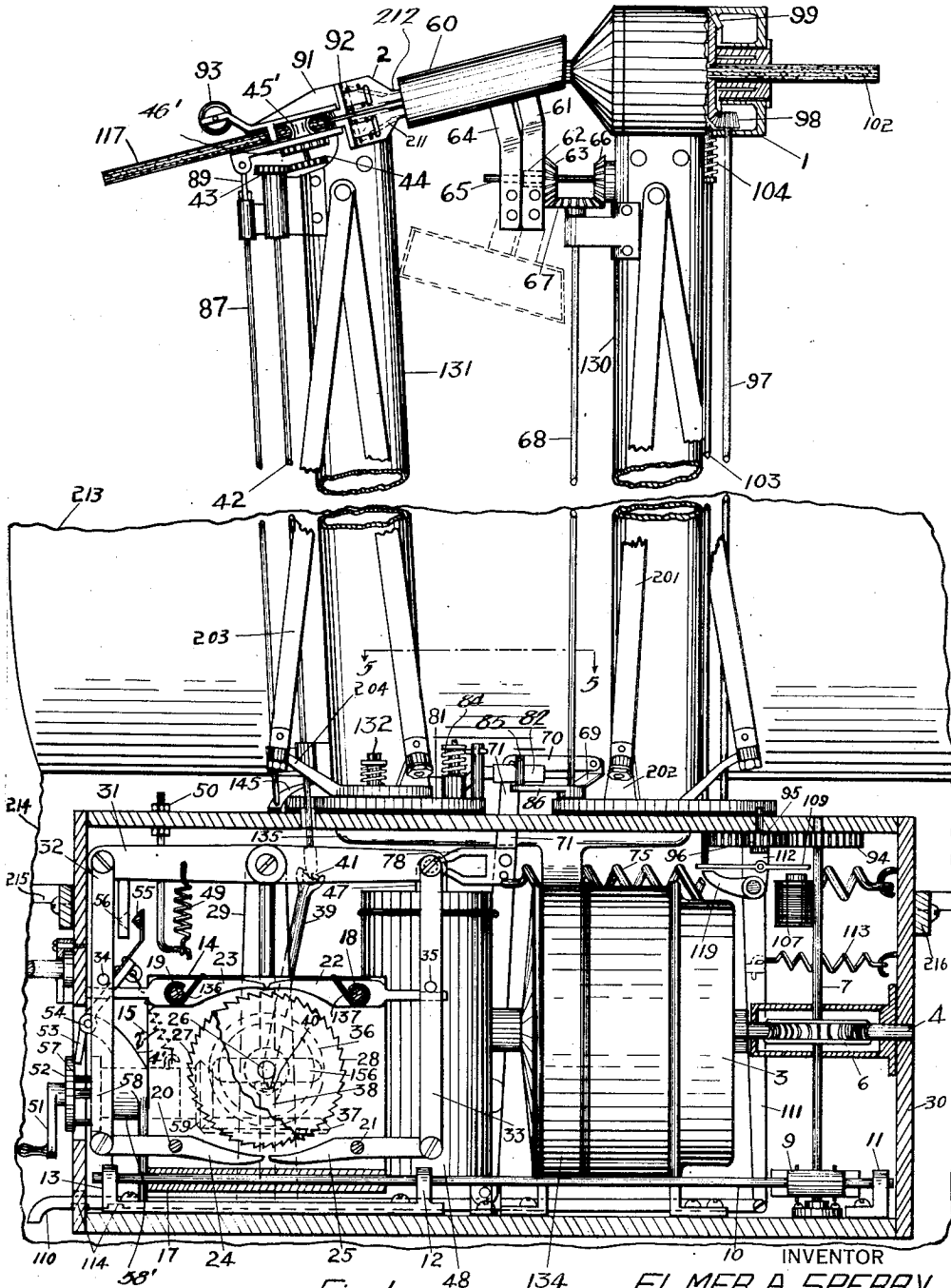


Fig. 1.

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 BY  
 Herbert H. Thompson  
 ATTORNEY.



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4 SHEETS—SHEET 2.

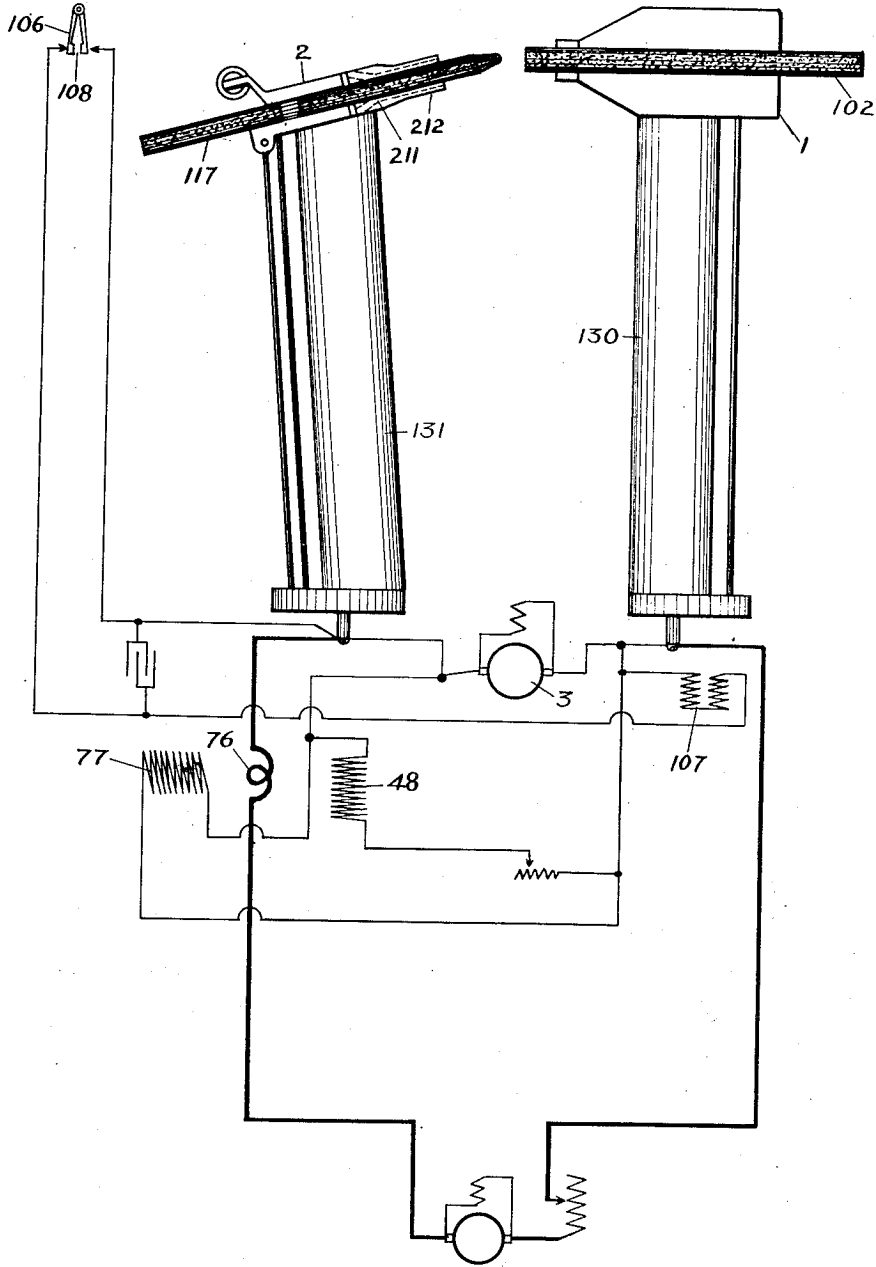


Fig. 2.

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 FEEDING MECHANISM FOR SEARCHLIGHTS.  
 APPLICATION FILED FEB. 7, 1917.

1,362,575.

Patented Dec. 14, 1920.

4 SHEETS—SHEET 3.

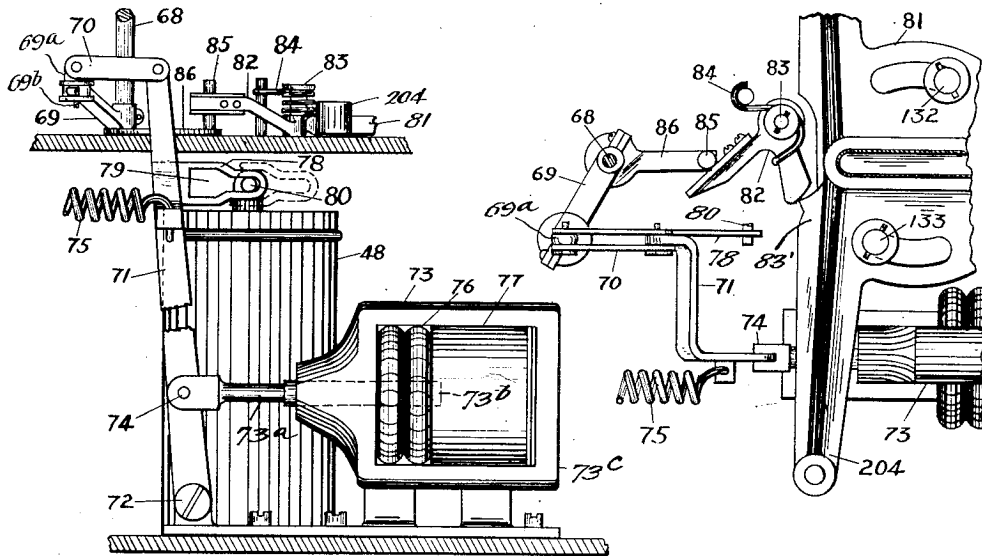


Fig. 4.

Fig. 5.

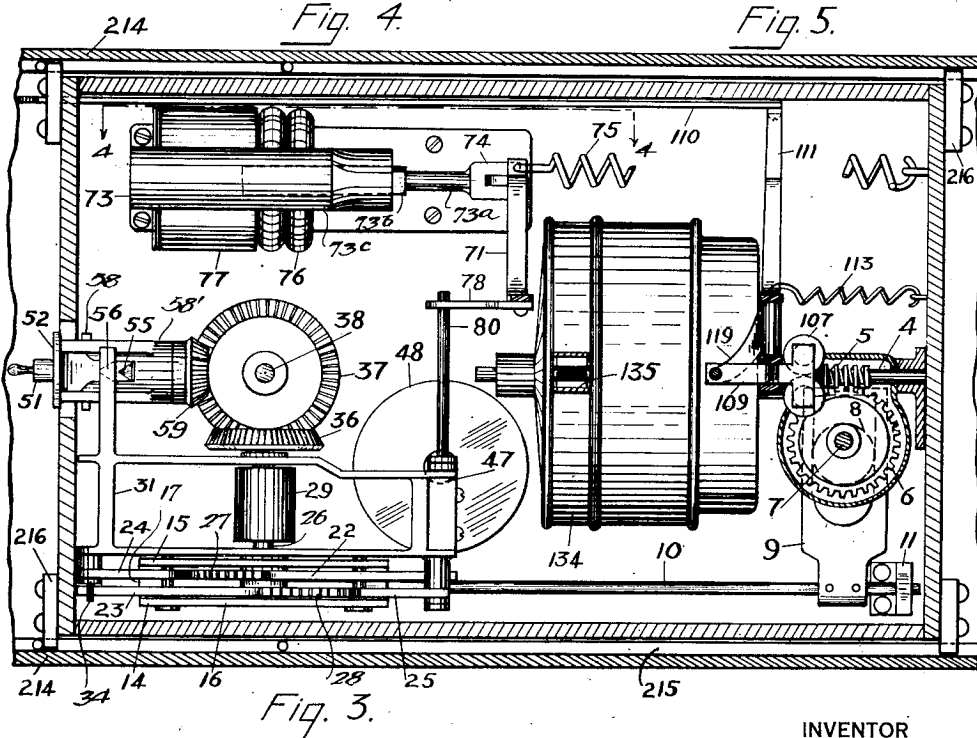


Fig. 3.

INVENTOR  
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 BY  
 Herbert H. Thompson  
 ATTORNEY.

E. A. SPERRY.  
 FEEDING MECHANISM FOR SEARCHLIGHTS.  
 APPLICATION FILED FEB. 7, 1917.

1,362,575.

Patented Dec. 14, 1920.

4 SHEETS—SHEET 4.

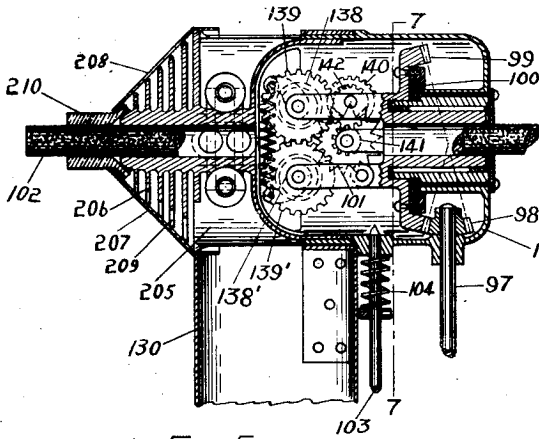


Fig. 6.

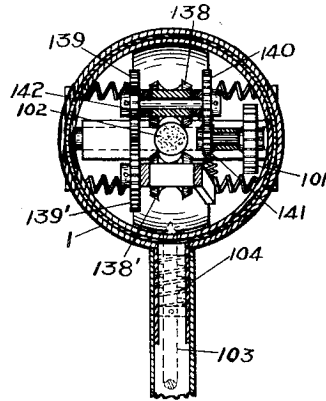


Fig. 7.

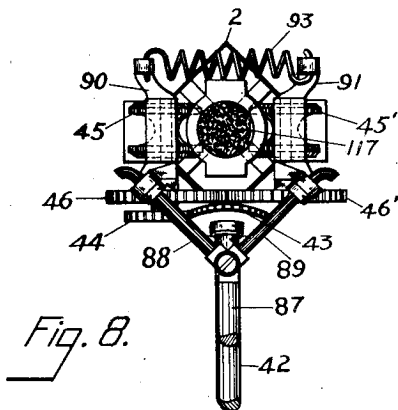


Fig. 8.

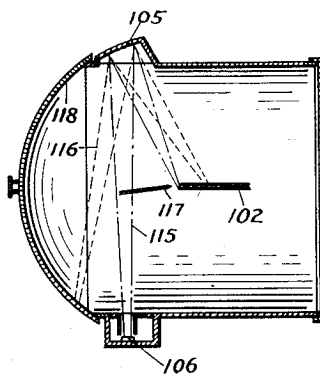


Fig. 9.

INVENTOR  
 ELMER A. SPERRY.  
 BY  
 Herbert H. Thomson  
 ATTORNEY.

# UNITED STATES PATENT OFFICE.

ELMER A. SPERRY, OF BROOKLYN, NEW YORK.

FEEDING MECHANISM FOR SEARCHLIGHTS.

1,362,575.

Specification of Letters Patent.

Patented Dec. 14, 1920.

Application filed February 7, 1917. Serial No. 147,071.

*To all whom it may concern:*

Be it known that I, ELMER A. SPERRY, a citizen of the United States of America, residing at 1505 Albermarle road, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Feeding Mechanism for Searchlights, of which the following is a specification.

10 This invention relates to improved electrode holders for high intensity searchlights, in which one or both of the electrodes is fed through the holder, and where-  
15 in means are provided adjacent to the holders for extinguishing the afterglow.

This application contains some of the matters disclosed in my pending applica-  
20 tion Serial No. 21,661 relating to improvements in searchlights, filed April 15, 1915, and as to such matters is a continuation of the same.

One object of my invention is to provide means whereby the negative carbon may be  
25 fed at various speeds in response to the various values of potential drop across the arc, and to use the same mechanism with which I accomplish this, to also strike the arc; most of the existing methods in actual use being  
30 to strike the arc and feed the carbon with different mechanisms.

I propose to provide means whereby the negative carbon may be fed up to the positive, for striking the arc, at a rapid speed  
35 until it touches the said positive carbon, and to then recede therefrom at a graduated speed varying inversely proportional with the potential drop across the arc, until the said potential reaches a predetermined value. The feeding of the carbon is then to be  
40 maintained by the same mechanism which will feed at speeds varying with the potential drop across the arc. When the feeding mechanism begins to operate, the distance through which the carbon is to be  
45 advanced is not always the same. The greater this distance, the more rapidly I propose to feed the carbon. With a variable speed feeding mechanism, capable of responding to the necessity of the moment, it  
50 will be seen that the desired arc length is maintained with remarkable accuracy, and therefore a maximum uniform brilliancy maintained.

Another object of my invention is to  
55 provide means for feeding the positive carbon whereby the crater of said carbon may

be kept constantly at a predetermined distance from the reflector.

A further object is to provide locking means which will prevent the arc from  
60 striking while the occulter or light quenching shields are closed, and also to prevent the occulter from closing while the arc is burning. The importance of this provision will be readily appreciated when it is  
65 understood that the intense heat from the burning arc would soon destroy the occulter if the latter were closed over said arc.

A further object of the invention is to  
70 provide means for causing the occulter to open part way when the negative carbon holder is turned to remove and replace the carbon, so as to set the carbon and holder free; and to close again when the carbon  
75 holder is turned back.

Referring to the drawings in which what I now consider to be the preferred form of my invention, is shown: Figure 1 is a side elevation partly in section of the control box containing the feeding mechanism  
80 with the carbon holders mounted rigidly thereon; most of the searchlight drum being cut away. Fig. 2 is a wiring diagram. Fig. 3 is a horizontal section through the control box showing the mechanism con-  
85 tained therewithin. Fig. 4 is a back elevation taken approximately on line 4—4, of Fig. 3 of means for operating the occulter. Fig. 5 is a detail taken approximately  
90 on line 5—5, Fig. 1, from the rear, showing the mechanism for opening the occulter when the negative carbon holder is turned to remove and replace the carbon. Fig. 6 is a sectional view of the head of the positive  
95 carbon holder. Fig. 7 is a cross section thereof taken at right angles to Fig. 6 on line 7—7. Fig. 8 is a rear elevation of the negative carbon head and Fig. 9 is a diagrammatic view of the arrangement of the thermostat for controlling the feeding  
100 of the positive carbon.

In Fig. 1 the searchlight drum is shown at 213, being mostly broken away. Extending downwards from the bottom of the drum are walls 214 in the sides of which  
105 are provided runways 215. The control box is shown at 30, having projections 216 which fit into the guideways, so that the box may be slid into place in a manner similar to that of a drawer. This may readily be  
110 seen in Fig. 3.

The head of the positive electrode holder

is shown at 1, mounted on the top of a hollow leg 130, which is in turn rigidly mounted on the top of the control box 30. Braces 201 fastened to the top of the leg and to arms 202 extending out from the base thereof, serve as braces to keep the holder rigid. The head of the negative electrode holder is shown at 2, mounted on the top of hollow leg 131, on the top of the control box, the entire holder being capable of rotation on its base 81 around pegs 132 and 133 (see Fig. 5) for removing and replacing the carbons. Strips 203 and arms 204 serve as braces for the negative holder.

In order to cool the electrode holders and a predetermined portion of each electrode, I provide a centrifugal fan 134 in the control box 30. This fan is operated by a motor 3 and forces a blast of air or other cooling fluid up through duct 135 into the hollow legs 130 and 131 of the positive and negative electrode holders respectively.

The air passes from the hollow leg 130 through a channel 205 (see Fig. 6) to heat extracting ribs 206 which surround the positive carbon 102 a short distance from the arc tip thereof, being prevented from escaping by a shield 207, fitting closely around the ribs.

A slot 208 is cut in the top of the shield, through which the air escapes. The ribs are cut away at their bottoms, forming a channel 209, so that the cooling blast may be properly distributed between the ribs.

Between the cooling ribs and the arc is positioned a highly refractory, heat insulating sleeve 210 which is designed to extend close to, but preferably to stop slightly back of the arc tip of the electrode. The said sleeve preferably forms an extension from the holder, being clamped to the forward end thereof. This sleeve performs several important functions, among which is that it maintains that portion of the electrode which it surrounds at white incandescence by reducing radiation and shielding it from heat abstracting air currents. It also shields the electrode from vaporization and oxidation, which at operating temperature would cause too great spindling of the electrode. The metallic holder also performs the last named functions, being joined to the sleeve.

The air entering the head of the negative holder from the hollow leg 131, passes through ducts 211 in contact fingers 212. The air emerges at the ends of the fingers and passes upward and out of the drum. The blast of air passing through the negative holder is limited by the size of the ducts so as to prevent the air from causing flickering of the arc.

On the shaft 4 of motor 3 is a worm 5 (see Fig. 3) which engages and turns worm wheel 6 on shaft 7. On shaft 7 is also fas-

tened a cam 8 or the like located within the forked member 9 which is rigidly secured to a rod 10 mounted in guides 11, 12 and 13. The revolving of the cam will impart a reciprocating movement to rod 10. Mounted on rod 10 is a carriage or pawl unit 14. This unit may consist of upright plates 15 and 16 which are integral with member 17 through which the rod 10 passes and is snugly fitted. In Fig. 1 plate 16 is removed to show the pawls, and member 17 is shown in section. Between the plates and secured thereto are placed pins 18, 19, 20 and 21 upon which are loosely mounted pawls 22, 23, 24 and 25 respectively. Mounted rigidly on a shaft 26 between said plates are two ratchet wheels 27 and 28; wheel 28 being partly broken away to show 27. The shaft 26 has its bearing in a post 29 which is secured to the box 30. The shaft passes through a slot 156 in plate 15. Shaft 26 carries at its other end a bevel gear 36 meshing with bevel gear 37 on shaft 38. Shaft 38 may be connected through an intermediate rod 39 and universal joints 40 and 41 to feed rod 42. At the top of the feed rod is a gear 43 meshing with gear 44. On the same shaft with gear 44 is provided one of the feed rollers 45 and another gear 46. Gear 46 meshes with a similar gear 46' on the shaft with which is provided the other feed roller 45'. The carbon 117 is placed between the feed rollers.

Pivotaly mounted at the top of post 29 is a rocking member or rocker arm 31. Pivotaly fastened at the ends of said rocker arm and extending downwardly are links 32 and 33. The bottoms of links 32 and 33 are in turn loosely secured to pawls 24 and 25 respectively. Pins 34 and 35 in links 32 and 33 operate to engage the tops of pawls 23 and 22 respectively and to hold them normally disengaged from the ratchet wheels, while springs 136 and 137 serve to press them into engagement with said wheels when released by said pins 34 and 35. Secured to one end of rocker arm 31 and extending downwardly therefrom is a bar 47 which serves as the core of a solenoid 48, the winding of which is placed in shunt with the arc circuit.

When the arc is not burning the full potential is maintained in the solenoid 48, the core 47 is drawn in, pulling down one end of the rocker arm 31. When the current is off, spring 49 pulls the other end of 31 down.

As previously explained, when the current is on and motor 3 is turning, the plates carrying the pawls, move back and forth, while the ratchet wheels remain in one place. Assuming now that the arc is not burning, the full potential will be maintained in the solenoid 48 and the rocker arm will be caused to tilt, raising link 32 and lowering link 33. Pawl 25 will be placed in contact

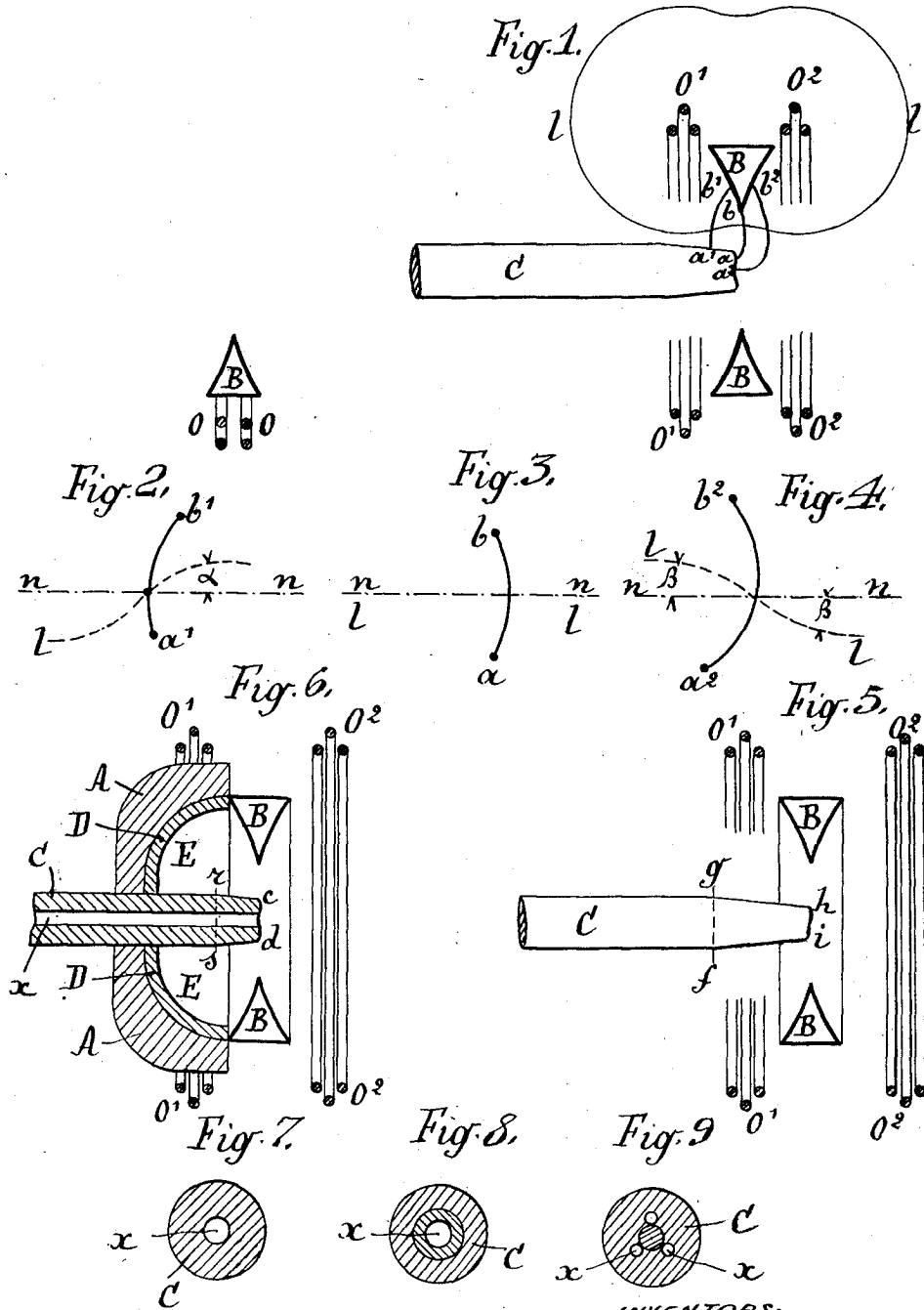
L. MAUCLAIRE, A. GARBARINI AND G. GAUTIER.

ELECTRIC ARC LAMP WITH ROTARY ARC.

APPLICATION FILED OCT. 23, 1917.

1,390,456.

Patented Sept. 13, 1921.



INVENTORS:

Louis Mauclair, Andre Garbarini  
and Georges Gautier

By W. H. S. Drosser, Danks & Meyers

# UNITED STATES PATENT OFFICE.

LOUIS MAUCLAIRE, ANDRÉ GARBARINI, AND GEORGES GAUTIER, OF PARIS, FRANCE.

ELECTRIC-ARC LAMP WITH ROTARY ARC.

1,390,456.

Specification of Letters Patent. Patented Sept. 13, 1921.

Application filed October 23, 1917. Serial No. 198,170.

To all whom it may concern:

Be it known that we, LOUIS MAUCLAIRE, ANDRÉ GARBARINI, and GEORGES GAUTIER, citizens of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Electric-Arc Lamps with Rotary Arcs, of which the following is a specification.

This invention relates to improvements in the construction of electric arc lamps with a rotary arc, used for the production of light, for the production of electric oscillations, and for all other purposes.

Embodiments of the invention are illustrated in the accompanying drawings.

In said drawings,—

Figure 1 is a view, principally diagrammatic, illustrating one embodiment of the present invention.

Figs. 2, 3, and 4 are illustrative diagrams illustrating the action of the magnetic fields upon the arc.

Fig. 5 is a view similar to Fig. 2, illustrating another embodiment of the invention.

Fig. 6 is a view illustrating an embodiment of the invention in a form somewhat more developed than in Fig. 2.

Figs. 7, 8, and 9 are cross-sectional views of electrodes provided with aspiration conduits for drawing off combustion products in the vicinity of the arc.

The improvements in arc lamps according to this invention have for their object to provide a lamp in which the rotating arc is stabilized by the use of two groups of coils or solenoids separate one from the other; further, the central carbon which is used is prevented from burning away prematurely by the arrangement of a refractory member into which the carbon passes, while the same member surrounds completely the space between the central electrode and the annular electrode. The central carbon employed is moreover provided with an internal passage or passages rendering it possible to draw away the fumes produced by the burning of the arc.

In the lamp which forms the subject of the present invention, the arc is stabilized by using two groups of coils situated at  $O^1$  and  $O^2$  (Fig. 1), that is to say in front of and behind the arc. The line of force produced by this combination of two groups of coils has the form indicated by the line  $l$  in Fig. 1. In this case when the arc

plays correctly between the central electrode C and the annular electrode B, that is to say from  $a$  to  $b$ , it cuts the field normally, and consequently a single couple is exerted on the arc causing it to turn. If the arc tends to play rearwardly between  $a^1$  and  $b^1$  or forwardly between  $a^2$  and  $b^2$ , it will cut the line of force in a variable direction.

In case the arc plays between  $a^1$  and  $b^1$  (Fig. 3) it will be seen that in addition to the couple acting on the arc and causing it to turn, there will be a force tending to move the arc forwardly depending upon the angle  $\alpha$  which the line  $l$  makes with respect to the normal  $n$ . In the case shown in Fig. 3, that is to say during perfect working, the normal  $n$  is coincident with the line of force  $l$ . If the arc plays between  $a^2$  and  $b^2$  (Fig. 5) the normal  $n$  makes an angle  $\beta$  with the line of force  $l$  which results in the production, in addition to the motive couple producing rotation of the arc, of a force tending to move the arc back to the points  $a$  and  $b$  which correspond to normal working.

The two groups of coils  $O^1$ ,  $O^2$  might be arranged to have, one with respect to the other, a preponderating action in view of the fact that the lamp is intended to be used for purposes requiring a very great intensity of light in a single direction, or even for industrial purposes for which it is desired to obtain an emission of light which is substantially constant in all directions (see Fig. 5).

Another disadvantage which exists in lamps with rotating arcs as hitherto known, results from the fact that when the arc is caused to play between the central electrode C and the annular electrode B, there is a violent movement of air which supports the combustion of the carbon C from the part  $f g$  (Fig. 5) to the part  $h i$ , this latter part being the only one which is useful, that is to say the crater.

Owing to this using up of the carbon which causes the electrode C to taper in a conical form, the section of the carbon between the points  $h i$  becomes much smaller than the section at  $f g$  which is the normal section of the carbon. Under these conditions the burning away of the carbon is very rapid, as the section of the carbon which is really utilized, is not the whole section of the carbon employed, but a very much reduced section defined by the crater  $h i$ . In order to

prevent this abnormal using up of the carbon, according to this invention an insulating member A (Fig. 6) is arranged behind the annular electrode B and bearing against this electrode, the member A being formed with a central hole for the passage of the electrode C. This insulating member A, which must be capable of withstanding high temperature, is covered internally with a layer D consisting of a mixture of rare earths and of thoria. With this arrangement the electrode C still becomes cut away at the end to a conical form, but to a comparatively slight extent as Fig. 7 shows, the points *r s* being much nearer to the points *c d*.

Moreover, as the section of the carbon at the points *r* and *s* is very little different from the section at the points *c* and *d*, if the closure effected by the member A is perfect, the following phenomenon takes place: Before the arc is started the chamber E is filled with air; when the arc is lighted this air allows a very slight combustion of the electrode C to take place, but after a very short time the chamber E will contain only gaseous oxid or carbon, which is the only body stable at this temperature. The arc as it continues to pass thus plays in an atmosphere which does not permit any unusual burning away of the electrode C, the part *c d* alone, which constitutes the crater, being in a state of very high incandescence.

When the lamp is to operate at a very high intensity, or when the electrode C is placed very close to the crater of the arc of optical appliances such as lenses, mirrors, condensers and so forth, said electrode C always produces some objectionable vapors. When such a lamp is employed with a projector for example, it is found necessary to have recourse to devices intended to protect the mirror from the fumes produced, and a glass plate is generally inserted between the arc and the mirror.

When the lamp is to be used for the purposes indicated above, an electrode C is employed, according to the present invention, formed with a small internal passage *x* (Fig. 6), while the end of the electrode distant from the crater is connected to a flexible pipe leading to an aspirator of any suitable kind.

With this arrangement, all the fumes produced by the combustion of the electrode C are drawn into the passage formed in this electrode and are thus removed. In addition to the great advantages of this method of aspiration in removing vapor and dust particles, another important advantage is secured resulting from the fact that the vapors and fumes are very hot, so that as they pass through the interior of the carbon they heat and dry the same; this has the effect of improving considerably the regularity of the burning of the lamp. It

is well known that when carbon electrodes are moist their operation is very defective. Various arrangements of the passages may be used for drawing away the vapors and fumes; for example, homogeneous carbons may be used having central longitudinal passages (Fig. 7) or in carbons having cores of a different composition, the passage may be formed in the interior of the core (Fig. 8) or two, three or more passages may be arranged around the circumference of the core (Fig. 9), while of course the composition of the carbons themselves can be varied according to the uses to which they are to be put.

#### Claims:

1. An arc lamp of the revolving arc type comprising a central carbon electrode and a surrounding annular electrode, and two separated solenoids whereby the rotating arc is stabilized, said solenoids being substantially concentric with the axis of said central electrode.

2. An arc lamp according to claim 1, in which the solenoids are arranged in planes on opposite sides of the plane of the annular electrode, and one has a preponderant effect over the other.

3. An arc lamp of the revolving arc type comprising a central carbon electrode and a surrounding annular non-consumable electrode, having an insulating member, said insulating member in conjunction with said annular electrode forming a chamber inclosing the space within the annular electrode on the side on which is mounted the central electrode.

4. An arc lamp of the revolving arc type comprising a central carbon electrode and a surrounding annular non-consumable electrode, having an insulating member, said insulating member in conjunction with said annular electrode forming a chamber inclosing the space within the annular electrode on the side on which is mounted the central electrode and a refractory layer on said insulating member.

5. An arc lamp of the revolving arc type comprising a central carbon electrode and a surrounding annular non-consumable electrode, having an insulating member, said insulating member in conjunction with said annular electrode forming a chamber inclosing the space within the annular electrode on the side on which is mounted the central electrode and aspirating means for drawing gases of combustion from said chamber.

6. An arc lamp of the revolving arc type comprising a central carbon electrode and a surrounding annular non-consumable electrode having connected thereto a refractory body of incandescing material forming therewith a chamber inclosing the space within the annular electrode on the side on which is mounted the central electrode.



7. An arc lamp according to claim 1, in which the central electrode has a passage through it, and aspirating means for drawing gases of combustion through such passage.  
5

8. An arc lamp according to claim 4, in which the central electrode has a passage through it, and aspirating means for drawing gases of combustion through such passage.  
10

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

LOUIS MAUCLAIRE.  
ANDRÉ GARBARINI.  
GEORGES GAUTIER.

Witnesses:

CHAS. P. PRESSLY,  
RENÉ BARDY.

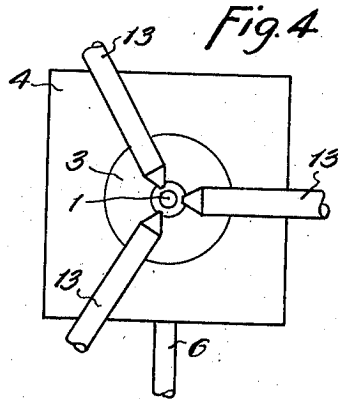
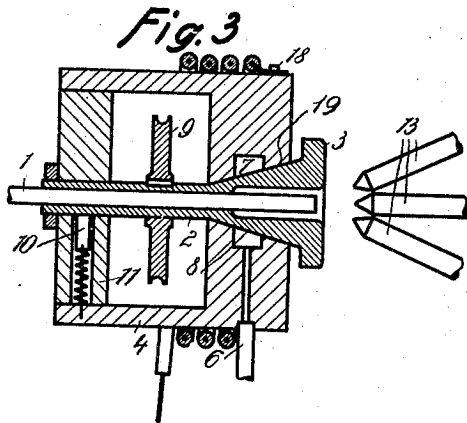
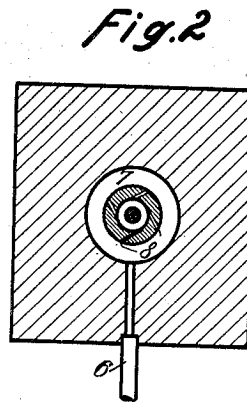
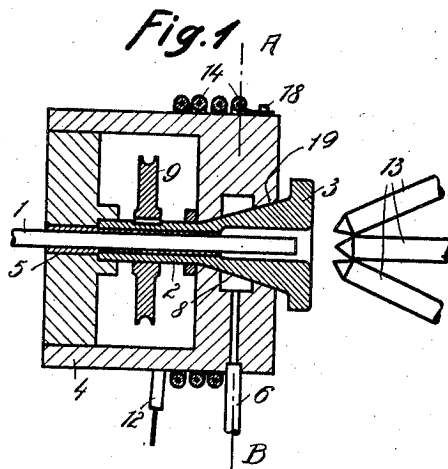
April 20, 1926.

H. GERDIEN ET AL

1,581,729

ARC LAMP

Filed Nov. 21, 1924



Inventors  
Kans Gerdien + Albert Lotz  
by Knight Bros  
attorneys

# UNITED STATES PATENT OFFICE.

HANS GERDIEN AND ALBERT LOTZ, OF BERLIN-GRUNEWALD, GERMANY, ASSIGNORS  
TO SIEMENS & HALSKE, AKTIENGESELLSCHAFT, OF SIEMENSSTADT, NEAR BERLIN  
AND ELSEWHERE, A CORPORATION OF GERMANY.

## ARC LAMP.

Application filed November 21, 1924. Serial No. 751,268.

*To all whom it may concern:*

Be it known that we, HANS GERDIEN and ALBERT LOTZ, citizens of the German Empire, residing at Berlin-Grunewald, Germany, Berlin-Grunewald, Germany, respectively, have invented certain new and useful Improvements in Arc Lamps (for which we have filed application in Germany on November 19, 1923), of which the following is a specification.

Our invention relates to improvements in arc lamps. The object of our invention is to increase the intrinsic brilliancy of such lamps. In order to increase the intrinsic brilliancy of an arc lamp it is necessary to contract the arc. The contraction of the arc is particularly reliable when it is effected by means of a layer or film of liquid.

According to our invention this layer or film of liquid is obtained by introducing the liquid into a revolving tube. The centrifugal forces generated during the rotation of the tube effect the formation of an extremely uniform layer or film of liquid upon the inner wall of the tube which contracts the arc with certainty and prevents its spreading to the outer surface of the anode.

In the drawing affixed to this specification and forming part thereof two embodiments of our invention are illustrated by way of example.

Fig. 1, is a longitudinal section through the improved arc lamp.

Fig. 2, a cross-section of the same on the line A—B in Fig. 1.

Fig. 3, a longitudinal section of a modified construction.

Similar parts are indicated by the same letters of reference in all the figures of the drawing, and

Fig. 4 is a right end view of the lamp shown in Figs. 1 and 3.

Referring to Fig. 1 it will be seen that the positive carbon 1 is slidably disposed in a guide bushing 5 of the casing 4 and surrounded by a tube 2 of slightly larger internal diameter. This tube 2 is provided with a flaring extension 3 which fits accurately into a conical or flared bore 19 of the casing 4. The tube 2 is adapted to be rotated by means of a cord pulley 9. Through the pipe 6 water serving for the covering of the inner walls of the tube 2 enters the annular channel or chamber 7 whence it passes

into the interior of the tube 2 by the tangential bores 8 which are clearly shown in Fig. 2. During the rotation of the tube 2 the water spreads in the form of a thin layer or fine film over the inner wall of the tube 2 owing to the centrifugal forces generated and ultimately flows out of the extension 3. All the parts of the tube exposed to the arc are thus covered with a thin film of water. The cathode consists of three carbons 13 inclined to one another at equal angles towards the anode, as shown in Fig. 4, which permits the unobstructed emanation of light from the anode in the direction of the anode axis. By means of a few turns of wire 14 traversed by a current, a magnetic field is generated which causes the arc to travel over the three negative electrodes whereby a uniform consumption of the electrodes is attained. From the terminal 12 connected with the positive pole the current passes through the turns 14 to the terminal 18 of the casing 4 and from here across the bushing 5 to the positive electrode.

Fig. 3 illustrates a slightly modified construction. Here the carbon 1 is firmly connected with the tube 2 so that the carbon revolves with the tube. The current is in this case introduced by the sliding contact element 10 which is pressed against the tube 2 by a helical spring 11.

What we claim is:—

1. In an electric arc lamp, in combination, a pair of electrodes, means for forming an electric arc between said electrodes, a rotatable tube surrounding said arc, means for imparting rotary motion to said tube and means for maintaining a film of liquid on the inner wall of said tube.

2. In an electric arc lamp, in combination, a pair of electrodes, means for forming an electric arc between said electrodes, a rotatable tube surrounding said arc, means for imparting rotary motion to said tube, and means for introducing liquid into said tube for forming a film on the inner wall thereof.

3. In an electric arc lamp, in combination, a pair of electrodes, means for rotating one of said electrodes, means for forming an electric arc between said electrodes, a rotatable tube surrounding said arc, means for imparting rotary motion to said tube and means for maintaining a film of liquid on the inner wall of said tube.

4. In an electric arc lamp, in combination, a pair of electrodes, means for rotating one of said electrodes, means for forming an electric arc between said electrodes, a rotatable tube surrounding said arc, means for imparting rotary motion to said tube, and means for introducing liquid required into said tube for forming a film on the inner wall thereof.
5. In an electric arc lamp, in combination, a pair of electrodes the anode of which is rotatable, means for forming an electric arc between said electrodes, a tube surrounding said arc and adapted to be rotated together with said anode, means for imparting rotary motion to said tube and means for maintaining a film of liquid on the inner wall of said tube.

In testimony whereof we affix our signatures.

HANS GERDIEN.  
ALBERT LOTZ.

July 27, 1926.

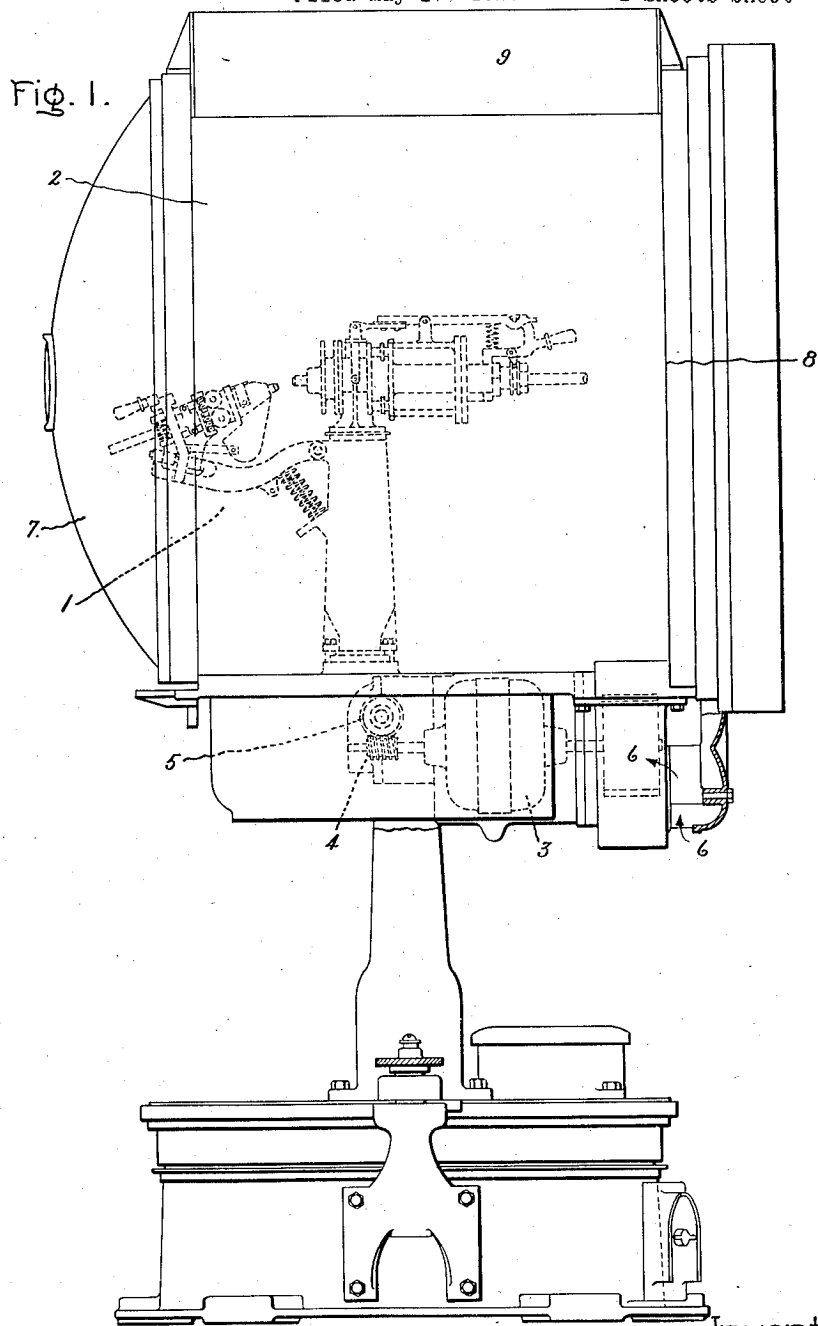
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E. J. MURPHY ET AL

SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 1



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1,594,067

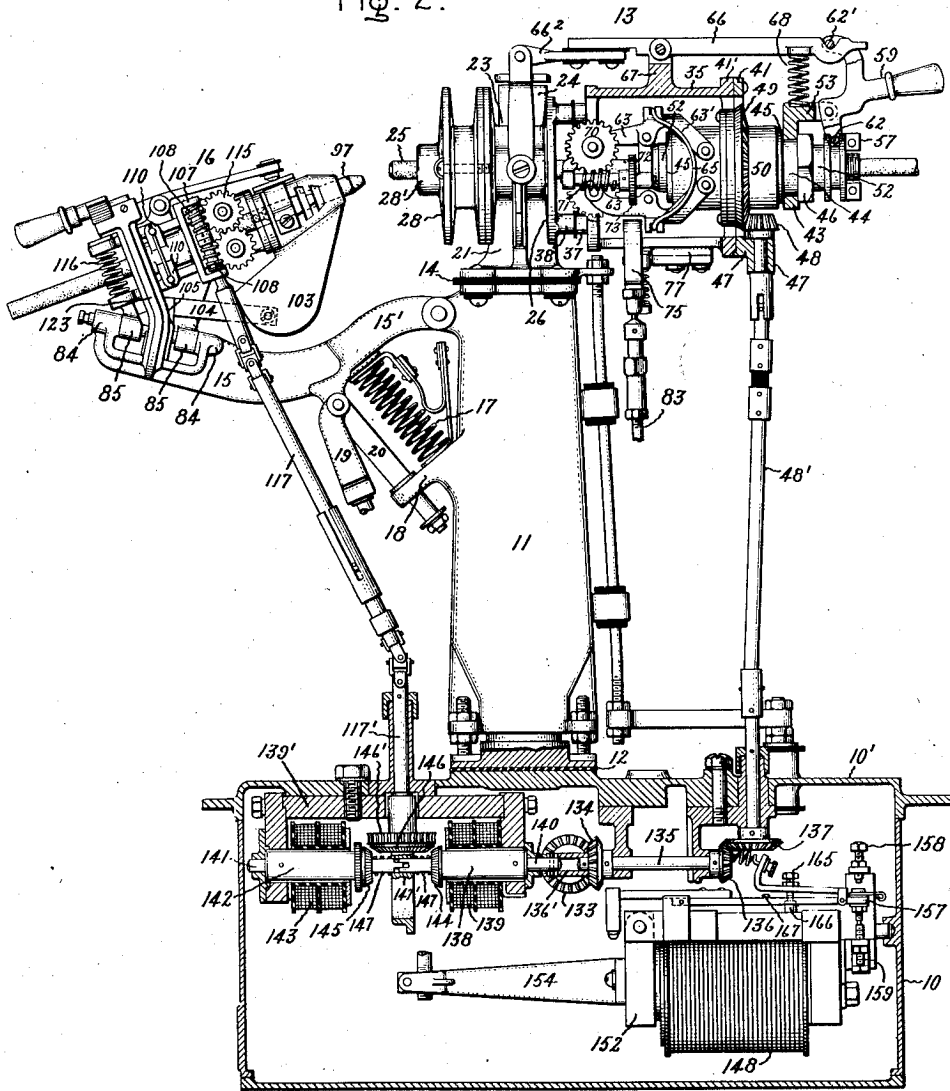
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SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 2

Fig. 2.



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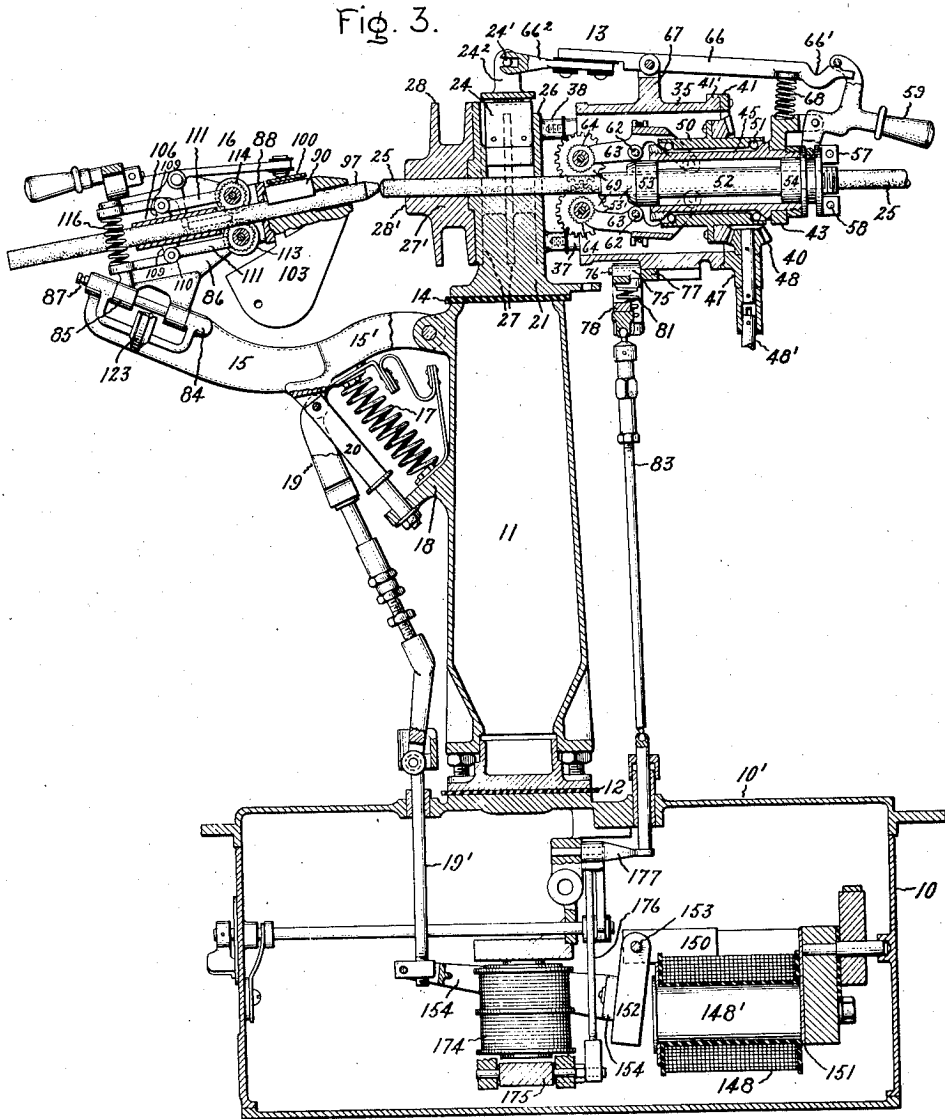
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SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 3



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1,594,067

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SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 4

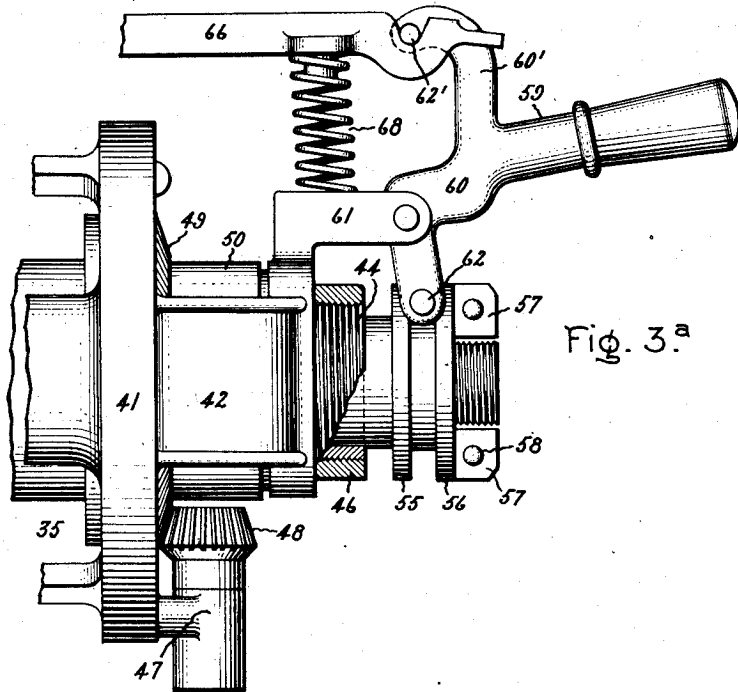
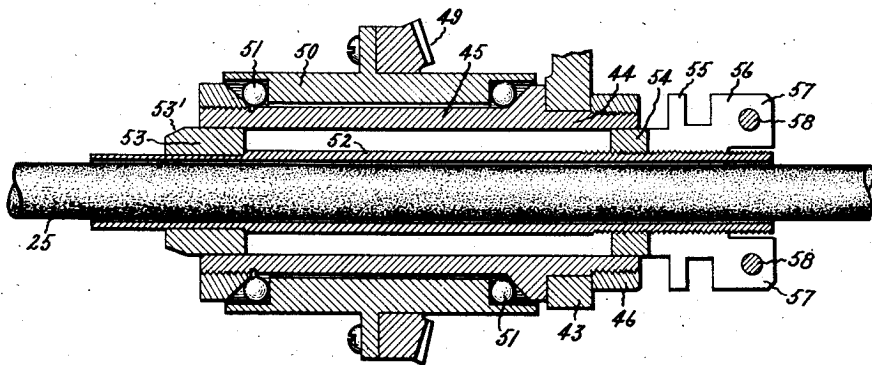


Fig. 3<sup>a</sup>

Fig. 4.



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1,594,067

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SEARCHLIGHT

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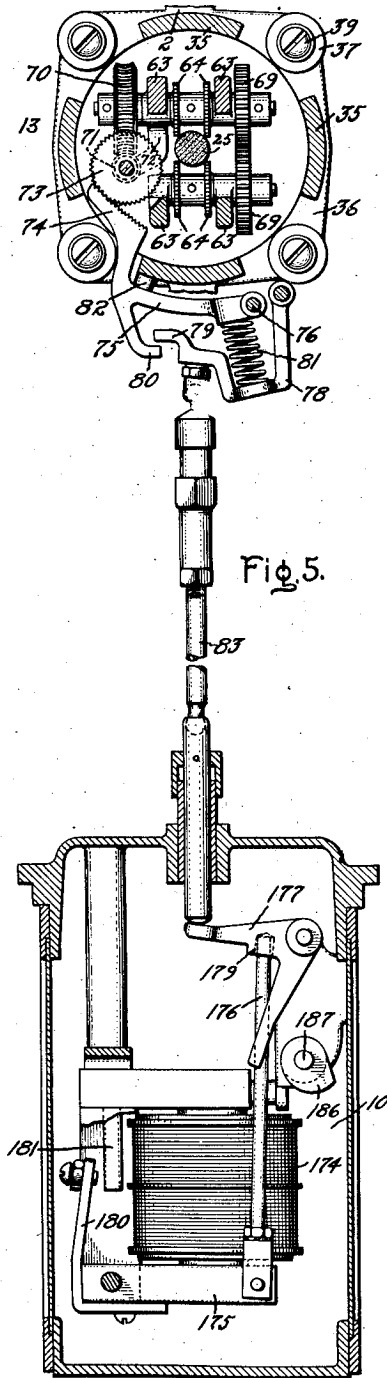


Fig. 5.

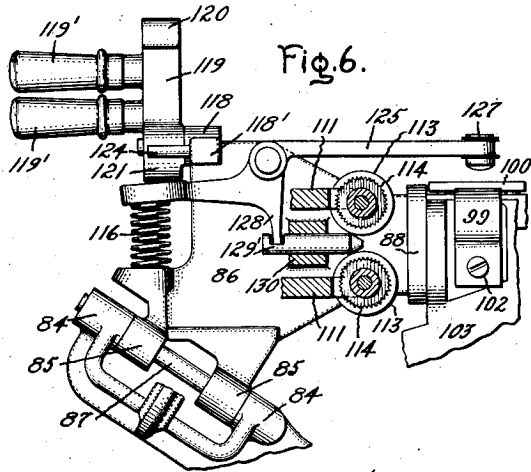


Fig. 6.

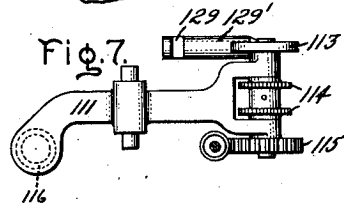


Fig. 7.

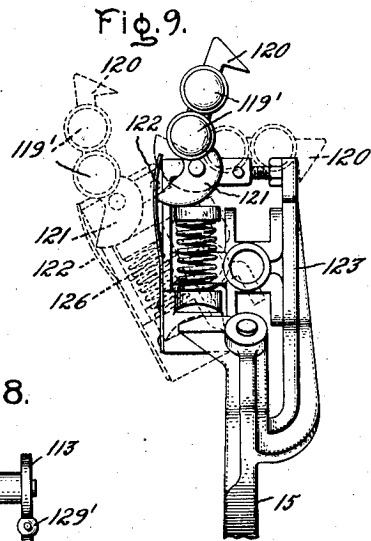


Fig. 9.

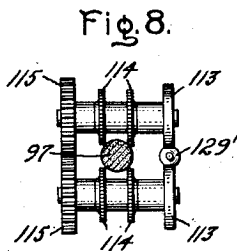


Fig. 8.

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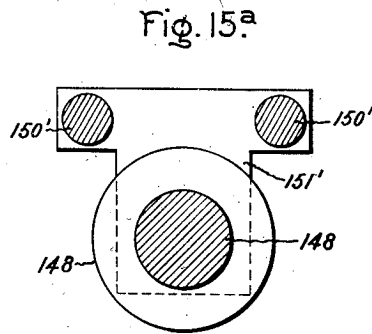
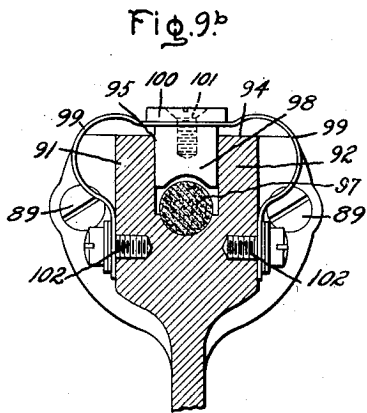
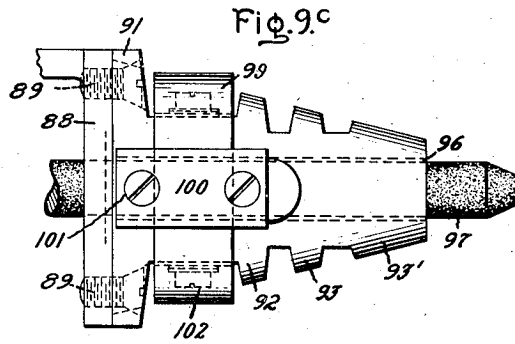
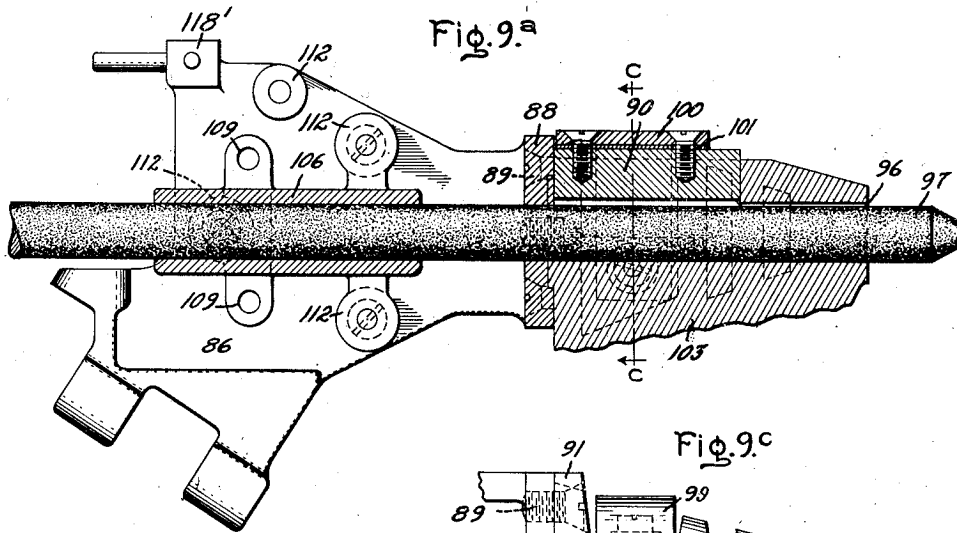
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SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 6



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1,594,067

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SEARCHLIGHT

Filed May 17, 1920

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Fig. 10.

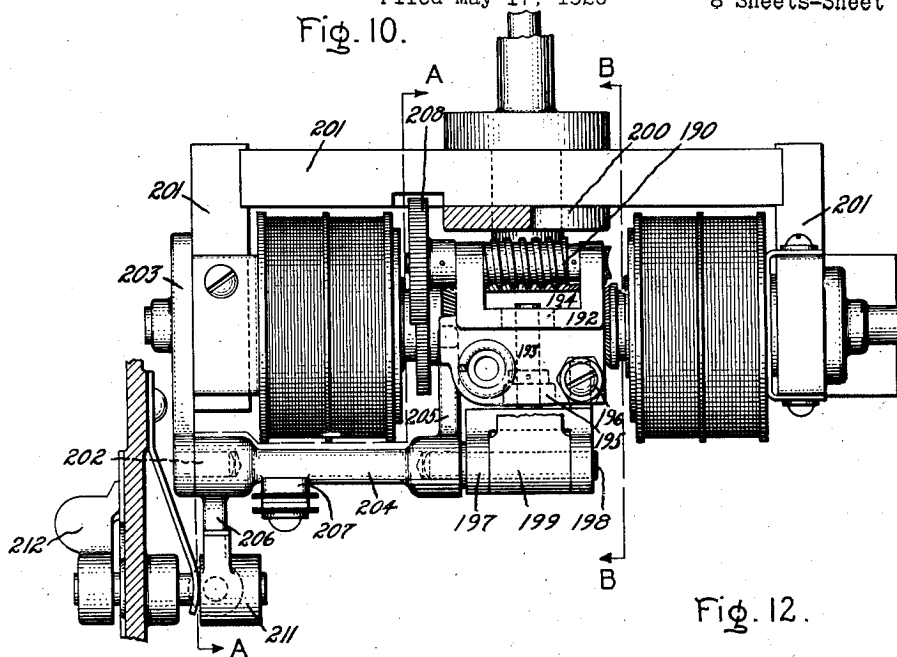


Fig. 11.

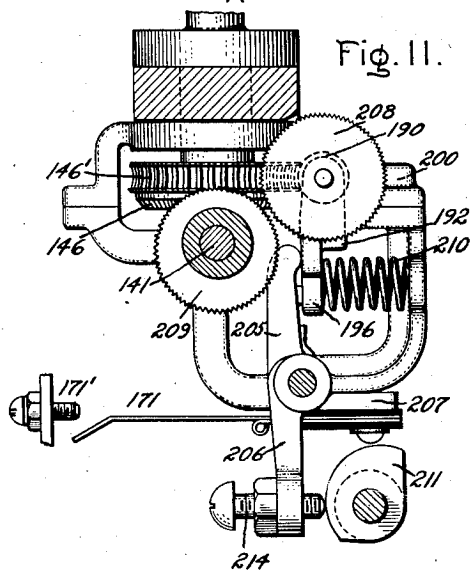
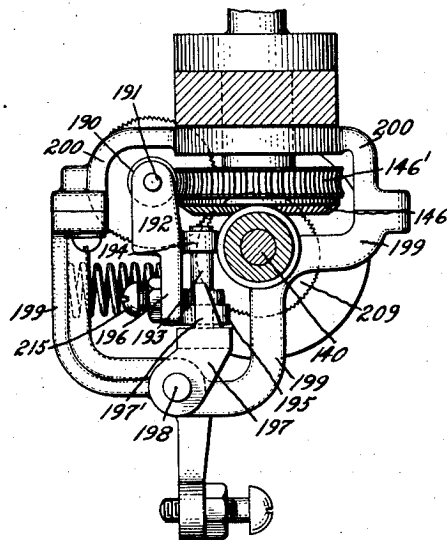


Fig. 12.



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July 27, 1926.

1,594,067

E. J. MURPHY ET AL

SEARCHLIGHT

Filed May 17, 1920

8 Sheets-Sheet 8

Fig. 13.

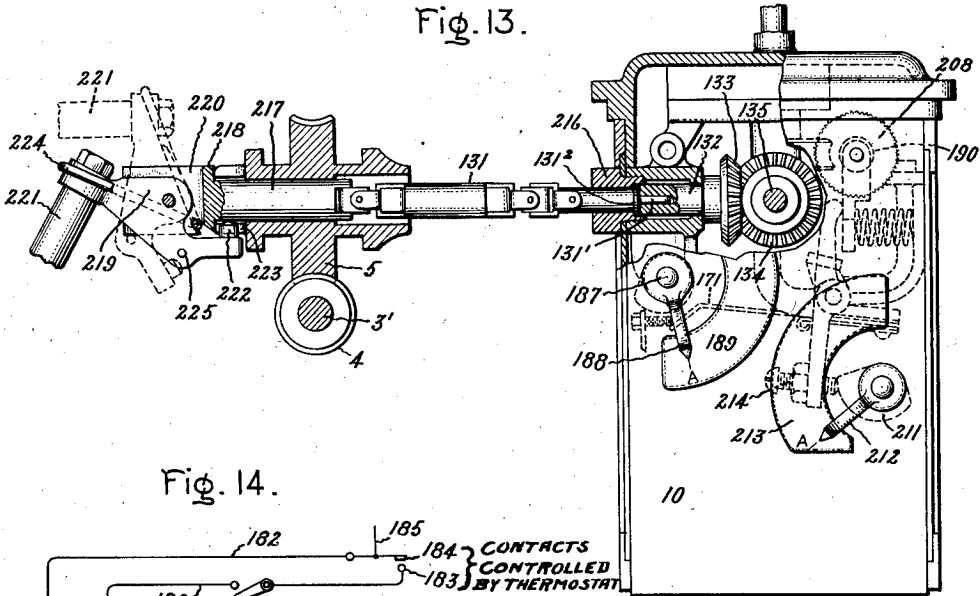


Fig. 14.

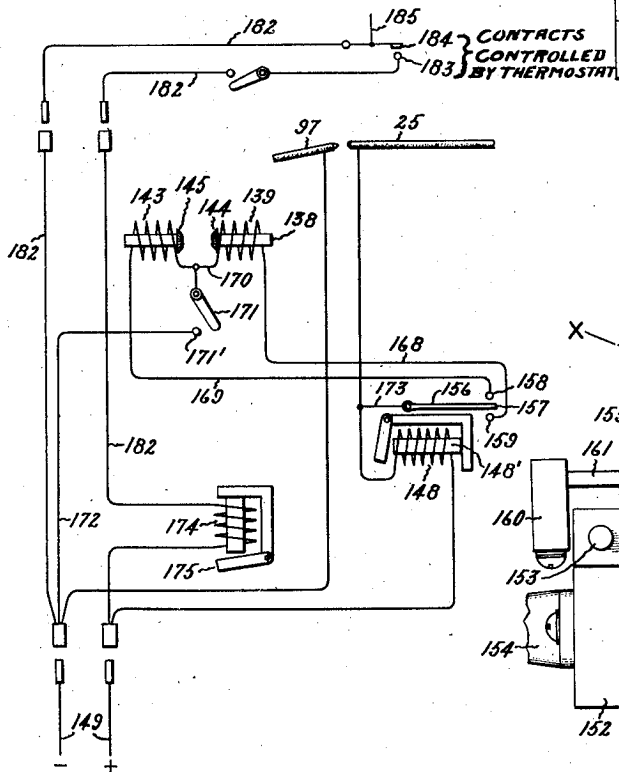
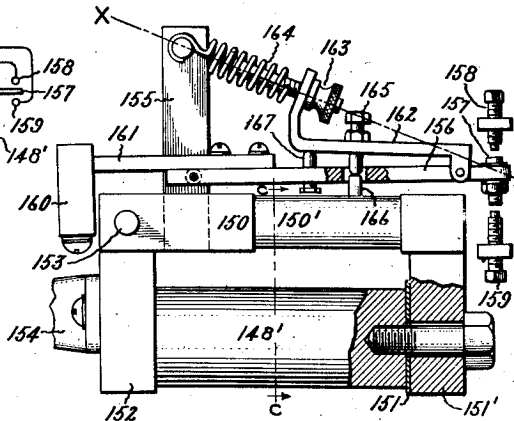


Fig. 15.



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 Their Attorney.

# UNITED STATES PATENT OFFICE.

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TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## SEARCHLIGHT.

Application filed May 17, 1920. Serial No. 381,904.

Our invention has reference to improvements in searchlights, and more specifically to arc lamps designed for use in connection therewith, although they are also adapted for use in other locations and for other purposes. When used for a searchlight the arc lamp is usually housed in a barrel equipped with a suitable reflector at one end and a window provided with a shutter at the other end. The positive electrode (anode) of the lamp is located with its crater end at the focus of the reflector and is there maintained by suitable regulating mechanism, while the negative electrode (cathode) is with its working end located and maintained at a distance to produce an arc of the desired or requisite length. In modern arc lamps of this general character the positive electrode is arranged horizontally, while the negative electrode is preferably inclined at an angle, pointing upwardly toward the crater end of the positive electrode. Provision is made for rotating the anode about its axis and for feeding both electrodes forwardly to compensate for consumption. When there is no current on the lamp the electrodes are in contact, and when current is turned on the arc is struck by withdrawing the cathode a suitable distance. Provision is also made for ventilating the searchlight barrel to remove the smoke and to cool the reflector.

Our invention is designed to secure a more reliable and efficient operation of a searchlight of this general character than has heretofore been accomplished, and we secure this result largely by automatically operating mechanisms actuated by a single motor and by novel arrangements of coordinated parts, which are particularly set forth in the following specification and defined by the claims appended thereto. The specification refers to the accompanying drawings, in which—

Fig. 1 is a side elevation of a searchlight with the parts of the searchlight lamp indicated in dotted lines;

Fig. 2 is a side elevation of the lamp mechanism, partly in section;

Fig. 3 is a central vertical section of the lamp mechanism, with some parts omitted for the sake of clearness;

Fig. 3<sup>a</sup> is an elevation, partly in section, upon an enlarged scale, of the rear end of the positive electrode head;

Fig. 4 is a vertical, axial section upon an enlarged scale of a portion of the rear end of the positive electrode head;

Fig. 5 is an enlarged vertical section at right angles to the plane of Fig. 3, showing the feed mechanism for the positive electrode;

Fig. 6 is a side view, partly in section, of a portion of the negative electrode head, showing the means for opening the holder and controlling the contact for the same;

Fig. 7 is a top view of a portion of the parts shown in Fig. 6;

Fig. 8 is an end view of the parts shown in Fig. 7;

Fig. 9 is an end view of the rear of the negative electrode head;

Fig. 9<sup>a</sup> is an axial section of the forward part of the negative electrode head upon an enlarged scale;

Fig. 9<sup>b</sup> is a transverse section on line *c-c*, of Fig. 9<sup>a</sup>, looking in the direction of the arrows indicated.

Fig. 9<sup>c</sup> is a top view of the parts shown at the right hand end of Fig. 9<sup>a</sup>.

Fig. 10 is a side elevation of the feeding and regulating control mechanism for the negative electrode;

Fig. 11 shows a section taken on the line A—A, of Fig. 10, looking in the direction of the arrows indicated.

Fig. 12 shows a section taken on the line B—B, Fig. 10, looking in the direction of the arrows indicated;

Fig. 13 is an end view of the control mechanism box, with a portion broken away to display part of its interior; also showing the drive mechanism and clutch outside the box;

Fig. 14 is a diagram of circuit connections;

Fig. 15 is an enlarged view of the relay controlling the feed of the negative electrode; and

Fig. 15<sup>a</sup> is a transverse section taken on the line C—C, Fig. 15, looking in the direction of the arrows indicated.

The general configuration of the searchlight indicated in Fig. 1 shows in dotted lines the location of the arc-lamp 1 within the drum 2; likewise the driving electric motor 3, the worm 4 and worm gear 5 actuated thereby, and the ventilating fan, all in dotted lines. Arrows 6, 6, indicate the influx of air to the fan. The reflector, us-

ually of the parabolic form, is mounted at the rear end 7 of the drum, and the window and shutter are mounted at the front end 8 of the drum, while the hood 9 affords an outlet for the air drawn in by the fan.

The rectangular box 10 (see Figs. 2, 3, 5, 13) contains the larger part of the lamp mechanism and the control magnets, and on the top cover 10' of the mechanism box is mounted the hollow standard 11, insulated from the cover by the insulating washer 12. The standard 11 directly supports the positive electrode head 13, insulated from the standard at 14, and an arm 15 bifurcated at one end 15' and there pivoted to a lug projecting from the standard, supports at its other end the negative electrode head 16. A helical spring 17, sufficiently strong to sustain the weight of arm 15 with its load, the negative electrode head, rests at one end upon a lug 18 projecting from standard 11, and bears with the other end upon the under side of arm 15. The swing of arm 15, and thereby of the negative holder, is caused by an adjustable pitman 19 pivoted to the arm 15. This pitman extends downwardly into the mechanism box and is actuated by an electro-magnet, as will appear further on. The movement of the arm 15 is steadied by a guide rod 20, pivoted to arm 15 and working in a guide hole in the lug 18.

The main body of the positive electrode head 13 is a framework composed of three parts, the most forward part being a casting 21, directly supported by the hollow standard 11. A slot 23 is formed in the upper wall of the casting 21, for the reception of a contact-plunger 24 which conveys the current to the positive electrode 25. The rear end of the casting 21 is closed by a plate 26, and the front part of this casting is formed with a number of heat-radiating ribs 27. To the foremost of these flanges is attached another casting 27', also provided with radiating ribs 28, and a central bore is formed through both and through which the positive electrode passes. The casting 27' terminates in front with a boss 28' which constitutes the nose of the positive electrode head. Both castings are made of good conducting non-oxidizable metal, preferably aluminum-copper bronze.

Immediately to the rear of the casting 21, is another casting 35, cylindrical in general outline, but otherwise an open framework, recognizable as such in Fig. 2, but particularly in Fig. 5. At the end adjacent to casting 21 the casting 35 is formed with a flange 36, approximately quadratic in outline and having a slightly projecting boss 37 at each corner; these bosses match like bosses 38, formed on the plate 26, and by screws 39, passing through bosses 37 and into bosses 38, the casting 35 is secured to casting 21, but the two castings are insu-

lated by insulating washers as indicated by black shading in Figs. 2 and 3 and by insulating sleeves in one set of bosses. The two sets of bosses 37, 38, hold the two castings apart, so as to leave an air space, between their adjacent ends.

A third casting 40, directly applied and secured to the rear end flange of casting 35, completes the framework of the positive electrode head.

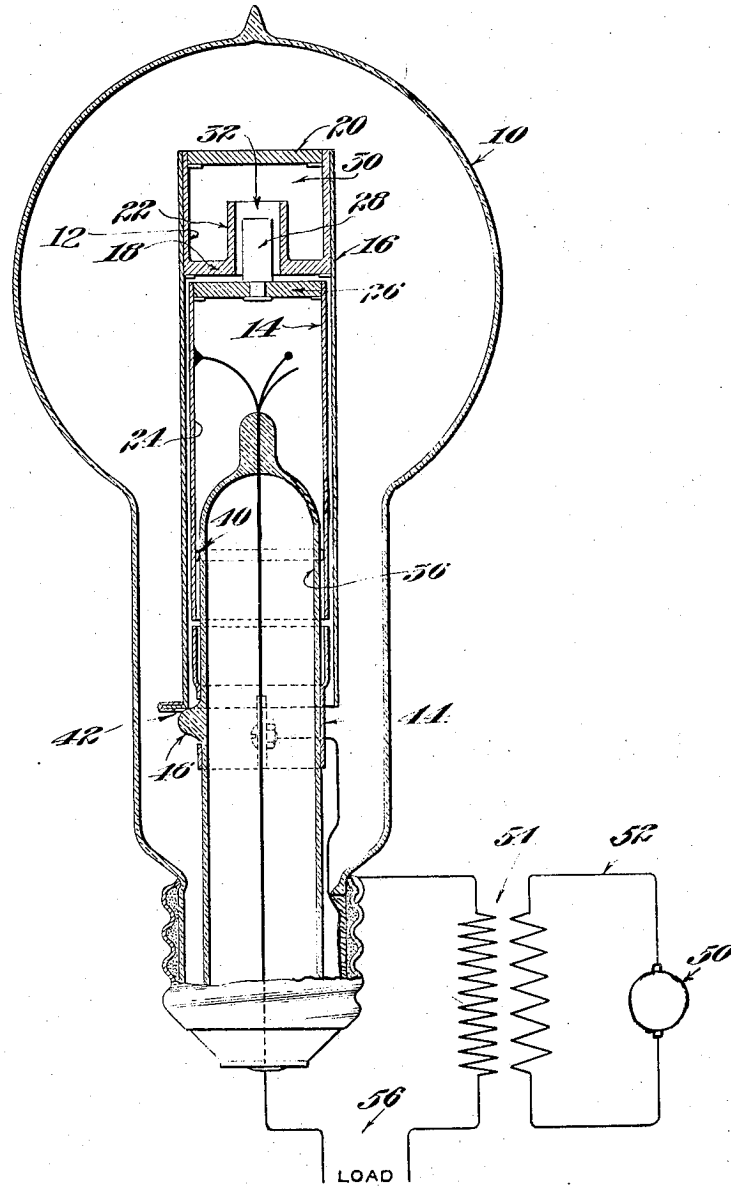
The casting 40 has at its forward end a flange 41, screwed into the rear end flange 41' of casting 35, and from diametrically opposite points of flange 41 two curved elements 42 (see Fig. 3<sup>a</sup>), extend rearwardly and then unite to form a hub 43, as a bearing or support for the neck 44, of a hollow cylinder 45 (see Fig. 4), which extends forwardly into the interior space of casting 35. The rear end of neck 44 is screw-threaded and is clamped in position against hub 43 by a nut 46; in this manner the cylinder 45 becomes, the same as casting 40, a stationary part of the positive head. From the lower part of flange 41 extends a bearing 47, in which a miter pinion 48 is journaled, which meshes with a miter gear 49, secured to a hollow cylinder 50, which surrounds the stationary cylinder 45 and is rotatable about the same on ball bearings 51.

Within the stationary cylinder 45 is a cylinder 52, which has an axial bore through which electrode 25 passes. This cylinder extends at both ends beyond the stationary cylinder and is liberally spaced from the same; it has fitted to it the bushings 53 and 54, the former at the front end of the stationary cylinder is there permanently fixed to cylinder 52, and the latter at the rear end of the stationary cylinder, is there screwed over cylinder 52, as a nut. This nut-bushing is at its rearward portion formed with two flanges 55, 56, and is there split into two parts, the flange 56 terminating in wings 57; screw bolts 58 passing through the wings serve as a means for clamping the bushing 54 at any position to which it may be adjusted on the cylinder 52. The inner wall of cylinder 45 is quite smooth and the bearing faces of bushings 53, 54 are also smooth, so that the latter may slide lengthwise with gentle friction within the cylinder 45, whereby the position of cylinder 52 with relation to the stationary cylinder 45 may be altered, for a purpose which will be presently explained. The means for moving the cylinder 52 lengthwise is a hand lever 59, pivoted with its bifurcated, downwardly extending arm 60 to a bracket 61, rising from hub 43. The prongs of this arm 60 straddle the flanges 55, 56, and a pin 62, extending between the prongs enters between the flanges, so that when the lever is rocked the cylinder 52 is moved a short distance lengthwise

Feb. 8, 1927.

1,617,179

C. G. SMITH  
ELECTRICAL APPARATUS  
Filed Dec. 31, 1921



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*M. J. Crozier*

*Inventor:*  
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*by his attorney*  
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## ELECTRICAL APPARATUS.

Application filed December 31, 1921. Serial No. 526,095.

The present invention relates to electrical apparatus and more particularly to apparatus of the type involving short path phenomena such as the apparatus disclosed in the application of Smith, Serial No. 415,536, filed October 8, 1920, and Patent No. 1,545,207, granted July 7, 1925.

It has been shown that the use of two electrodes immersed in a suitable gaseous medium and having their active surfaces spaced apart a distance which is insufficient to normally permit ionization of the gas enables certain new and valuable results to be obtained by controlling the paths of electrons between the active surfaces of the electrodes in such a manner as to vary the ionization of the gas. In the aforesaid patent, this control of the paths of electrons is accomplished through the use of a magnetic field applied in such a manner that the paths of electrons leaving one electrode when this electrode acts as a cathode are sufficiently long to cause substantial ionization and consequent gaseous conduction, whereas the paths of electrons leaving the opposite electrode when the latter acts as a cathode are so short as not to cause substantial ionization and gaseous conduction, making this form of apparatus in effect a rectifier of alternating currents. By a suitable control of these paths it will be obvious that such an apparatus may be caused to function as a modulator and oscillator as well as a rectifier.

I have discovered in this connection that it is possible to effectively vary the ionization by other than magnetic means and according to the present invention the ionization depends upon a space charge effect. In carrying out the invention, I employ two electrodes immersed in a gas and so located with respect to one another that all paths are short except paths entering a hollow space through an opening in the surface of one of the electrodes. With a construction of this sort, a large number of positive ions collect close to the inner cathode surface while current is being passed between the electrodes and a positive space charge is created. This space charge causes gaseous conduction to take place between the electrodes when the hollow electrode is negative but, on the other hand, no appreciable current passes in the opposite direction.

In the actual construction of apparatus embodying this principle, it is sufficient that the electrodes be so constructed and arranged with respect to one another that all paths through the gaseous medium shall be sufficiently short to prevent conduction except paths through an opening of proper size in one of the electrodes, and all paths available for conduction through the insulating medium shall be sufficiently long to prevent breakdown under the applied voltage.

A further feature of the present apparatus is due to the fact that the gaseous discharge is entirely confined to a space surrounded by electrode material. This avoids bombardment of the insulating dielectric by positive ions and electrons. Such a provision is highly important as it prevents the formation of a charge on the insulating material with consequent erratic operation of the tube, which is the usual result of such a charge. The confinement of the area of discharge to a space entirely surrounded by electrode material is an advantage which can only be obtained with a tube embodying the new principles above set forth.

The accompanying drawing illustrates a form of tube embodying the new features of the present invention.

The illustrated embodiment of the invention shown in the drawing comprises a hermetically sealed receptacle 10 filled with helium or other suitable gas and having co-operating electrodes indicated generally at 12 and 28 immersed therein. The electrode 12 comprises a hollow cup 18 received within the upper end of a tubular member 16 and closed by a disk 20. As indicated, the hollow cup 18 is provided with an upstanding neck or sleeve portion 22. The cooperating electrode 28 is carried by a tube 24 received within the tube 16 and mounted concentrically therewith, the tube 24 having a metallic disk 26 mounted in the upper end, which supports the anode proper in the form of a projection or pin 28 extending into the opening formed by the sleeve 22. The space separating the opposing walls of the tubes 16 and 24, the opposing faces of the cup 18 and disk 26, and the opposing walls of the sleeve 22 and pin 28 are all short and of the order of magnitude of the mean free path of electrons in the gas in which the electrodes are immersed, this spac-



ing causing the tube to normally insulate against gaseous conduction with the two electrodes at different potentials at all points except the space provided for conduction.

5 The construction of the outer electrode 12 provides a hollow space, indicated at 30, within the cup 18, this hollow space communicating with the space separating the two electrodes through an opening 32 formed in the upper open end of the sleeve 22.

10 The provision of this hollow space to which communication is afforded by the opening 32 causes the device to conduct current when the outer electrode 12 is negative. This characteristic of the device is due to the formation of a positive space charge in the area 30 after the operation of the tube has started. This positive space charge consists of a large number of relatively immobile positive ions which may persist in appreciable numbers from one cycle to the next and which form a cloud in the space opposite the opening. The effect of this charge is to cause conduction to take place freely through the space between the pin 28 and the interior of the hollow electrode when the hollow electrode is negative. On the other hand, when the electrode 12, which may be termed the "solid electrode", is negative, no substantial current passes through the tube as all of the space available for conduction is either too short to permit cumulative ionization of the gas or else is blocked by the effect of the positive cloud. Furthermore, it will be observed that the gaseous discharge is confined to a region which is completely surrounded by electrode material, avoiding the possibility of any stray ions or electrons bombarding the walls of the receptacle or other dielectric and setting up in consequence a charge, which would tend to render the operation of the tube erratic. The inner electrode tube 24 may be conveniently supported upon the upper end of a projection 36 extending from the lower end of the receptacle 10 and formed of insulating material. This tube surrounds the glass projection closely without actually contacting with it in order that the heated material of the metal tube when in action shall not tend to crack the glass. In order to support the tube, it has been found convenient to insert a thin spacer ring 40 between the tube and the glass projection, as indicated. The tube may also be supported by a branching wire, which extends upwardly from the projection 36 and is connected to the inner wall of the tube, as indicated, this projection serving as one of the leading-in wires. The outer electrode tube 16 projects downwardly below the end of the inner tube and is connected to a lip 42 projecting outwardly from a sleeve 44, this sleeve embracing the projection 36 closely and being supported by a shoulder 46 cast upon the projection as indicated. With this construction it will be observed that possible discharge paths through the gaseous space separating the surfaces of the electrodes are invariably short with the exception of those in the discharge space and that all of the spaces available for discharge through the insulating dielectric are sufficiently long to avoid breakdown. Furthermore, the relatively hot walls of the electrode tubes 16 and 24 do not directly contact with the glass so that liability of the glass cracking is avoided. Aside from these advantages as enumerated, this type of device has the further advantage that an enclosing receptacle may be employed of any desired size with a comparatively large body of gas immersed therein. This is a distinct advantage as the convection currents set up in this gas tend to dissipate heat from the electrode tubes and permit a comparatively large current to be passed through the apparatus without detrimental effect. It will be observed that the outer electrode 12 constitutes the cathode when the apparatus is conducting. As the cathode naturally becomes hotter during the operation than the cooperating electrode, the dissipation of heat therefrom is facilitated owing to the fact that it is in direct communication with the comparatively large enclosing body of gas.

The tube may be conveniently embodied in any suitable form of circuit such as shown in the drawing. This circuit may comprise a source of alternating current, indicated at 50, embodied in a primary circuit 52 and coupled with the tube circuit through the connection indicated at 54, the tube circuit having any suitable form of load, indicated at 56, connected therein, together with capacity and inductance, as may be needed with circuits of this character.

It will be understood by those skilled in the art from the foregoing description that this type of tube functions according to the broadly new principle underlying the operation of the apparatus disclosed in the Smith application and patent above referred to. This principle recognizes first that it is possible to so separate electrodes immersed in a gas that cumulative ionization and conduction may be prevented. This principle is here utilized to limit the discharge to a small area where it can be so controlled by the effect of a space charge as to be uni-directional.

In the Smith application above referred to, a tube which normally insulates against conduction in either direction may be caused to conduct in one direction by the imposition of a magnetic field of the requisite strength, which diverts and lengthens the paths of electrons sufficiently to set up cumulative ionization. According to the present disclosure, this same result is effected

by the proper design and construction of the opposing electrodes in such a manner that a space charge effect is created at the discharge point to allow conduction when the hollow electrode is negative, the tube insulating against conduction in the usual manner when the opposing electrode is negative.

This is due in considerable measure to the widely dissimilar areas of the active surfaces of the cathode and anode (the interior surface of the large cathode and the upper end of the small anode) in conjunction with the electrical characteristics of the gas filling. When using helium the anode loss is abnormally low during the half cycles when the cathode is negative due to the fact that helium is a monatomic gas comparatively free from negative ions which magnify the anode losses. Thus there is less heating at the anode and less tendency for the anode to disintegrate. Consequently, the anode may be made smaller than in other rectifiers of the large and small electrode type filled with air, thereby affording more complete rectification by virtue of the greater difference in area of the active surfaces of the electrodes.

When using helium the reverse current, during the half cycles when the anode is negative, is abnormally low and consequently this rectifier affords more complete rectification for this reason also, and owing to this low reverse current, the anode losses and disintegration are also lower during reverse half cycles. This desirable phenomenon is believed to be due to the abnormally long mean free path of electrons in monatomic gases, particularly helium.

By restricting the path of approach to the small anode by wall 22, the rectifying characteristics are further improved; and by virtue of the close spacing between wall 22 and the anode, effective insulation results from the aforesaid short path principle. As described and claimed in companion application Serial No. 464,358, filed April 21, 1921, the monatomic gas also has the function of permitting the short spacing between the electrodes to be made longer for the same degree of insulation, thereby facilitating the manufacture.

While argon and other inert gases have longer mean free paths for slow speed electrons (below ionizing velocity), I have discovered that for high speed electrons (above ionizing velocity) helium is unique in that it has a much longer mean free path. Consequently, in a gaseous conduction tube helium minimizes disintegration of the electrodes (when negative) for the following reasons: The average distance from the electrode at which ions are produced by high-speed electrons in helium is greater, and the ions in falling through this greater distance to the electrode are more retarded

by intervening molecules so that they impinge upon the electrode with less force, it being known that the velocity of the ions when unobstructed by intervening molecules depends upon the voltage drop and not upon the distance they have to travel to the electrode.

In order to avoid variations in the gas pressure and disintegration of the hollow cathode member, it has been found desirable to provide a small quantity of metallic tin inside of the space 30. This metallic tin may conveniently be amalgamated to the iron or other metal comprising the cup 18, forming a thin coating over the internal surface. During the normal operation of the tube this tin is in a liquid condition. When the tube ceases to operate and the electrodes are reduced in temperature, the tin hardens into a solid form so that the tube may be freely handled without liability of the tin leaving the hollow space 30. Even in the molten condition it is extremely difficult for the tin to run out or be shaken out of the hollow cathode due to the configuration of this member with the upstanding sleeve 22 and to the attraction of the tin for the underlying and supporting metal.

Thus it will be evident that the invention exemplified by the embodiment above described has the following unique characteristics. The anode surface is presented to the cathode surface through a restricted opening to which the anode is closely adjacent, the obstruction which contains the opening preferably being of metal and forming a part of the hollow cathode. In a glow-discharge (non-arcing) tube having a solid (non-vaporizable) cathode surface, this arrangement has the unique function of trapping ions in the restricted region adjacent the cathode surface, thereby tending to restrict back current during alternate half-cycles when the anode is negative. By making the space between the anode and the periphery of said opening sufficiently short (as described above and in said co-pending application) the space is insulating at normal potentials. A gap of similar length may be provided between the anode and the exterior of the cathode and/or a tube (16) surrounding the anode. The cathode has a flange surrounding said opening, preferably inside the cathode, and the anode preferably projects into the neck formed by the flange. However, the anode preferably terminates short of the mouth of the neck to provide greater space charge adjacent the active face of the anode more effectively to restrict back current from anode to cathode. The mouth of the cathode neck constitutes an orifice providing an ionizing path or passage and the cathode is large enough in diameter to provide an opposing face to the entire outer edge of the anode. The opposing surfaces

of parts 18 and 26 constitute broad plane surfaces arranged close together with a gap therebetween whose length is less than or at least comparable to the mean free path of electrons in the space. The part 20 constitutes shielding means in line with the aforesaid ionizing passage; and the neck 22 comprises a cylindrical wall extending at substantially right-angles to the face of the anode.

From the foregoing it will be evident that the anode projection 28 and the surrounding cathode flange 22 constitute means additional to the space charge for selectively causing electrons passing in different directions through the gas to take paths of widely different lengths. A modification of such means is described and claimed in my co-pending application Serial No. 654,642.

Each end of the cylindrical cathode is closed, the upper end by a separately formed cover 20 and the lower end by the integrally formed cover 18, the space within the cylindrical cathode thus being entirely confined except for the restricted opening 32 in cover 18.

A novel feature of the invention consists in that means are provided for preventing the discharge, as well as radiation from the discharge, from reaching any insulation material, thereby prolonging the useful life of the tube. In the illustrative embodiment the parts 14, 16 and 26 entirely shield the insulating stem 36 as well as the interior surface of the tube 10. This is preferably accomplished by confining the active area of the cathode to the interior thereof and confining the active area of the anode to that portion presented to the interior of the cathode. For this purpose I preferably employ a member (such as 26 in the illustration) which extends outwardly from approximately the diameter of the anode at least to approximately the diameter of the opening. This member preferably has a surface spaced from one electrode a distance substantially confined to the mean free path of electrons in the gas, this short gap being disposed between member 26 and the cathode in the illustration.

The invention is also characterized in that the current (whether gaseous or metallic conduction) is entirely confined to the aforesaid restricted opening. Thus in the illustration all of the current flows through the restricted opening 32, by metallic conduction through that portion of the anode disposed in the opening and by gaseous conduction from the upper end of the anode to the upper end of the opening defined by neck 22.

In a generic sense the term hollow cathode includes a cathode whose active surface only partially surrounds a gaseous medium so that the medium immediately adjacent the

active surface is more or less pocketed or confined.

Another feature of the invention consists in that the active area of the anode is small in comparison with the total surface of the anode (in the illustrative embodiment only the tip of the anode 28 is active), whereby the heat generated at the active area of the anode by the back current during half-cycles when the anode is negative may be dissipated much more rapidly. Owing to this unusually rapid dissipation of heat the current density may be increased without heating the active anode surface hot enough to cause arcing. The larger permissible current density permits the use of a higher gas pressure, the density of the back current being approximately proportional to the square of the density of the gas. Thus the relatively small anode surface not only is important in itself to prevent arcing, but it permits the use of a higher pressure which protects the cathode as described in prior application Serial No. 464,358.

While it is preferred to employ the specific construction and arrangement of parts shown and described it will be understood that this construction and arrangement is not essential except so far as specified in the claims and may be changed or modified without departing from the broader features of the invention.

By having the free end of the anode (upper end in the illustration) terminate in the region of the opening in the obstruction between the active surfaces of the cathode and anode, the tube is rendered much quieter when used in connection with radio sets or other telephone transmission and at the same time the tube starts operation more easily.

The invention having been described, what is claimed is:

1. Electrical apparatus comprising a hollow electrode having an opening therein, another electrode presented to the interior of the hollow electrode through said opening and having its free end terminating in the region of the opening, and means for obstructing discharge between the second electrode and the exterior of the hollow electrode.

2. Electrical apparatus comprising a hollow electrode having an opening therein, another electrode presented to the interior of the hollow electrode through said opening, the active area of the second electrode being confined approximately to one end thereof and to the cross-section area of said opening, and means for obstructing discharge between the second electrode and the exterior of the hollow electrode.

3. Electrical apparatus comprising a hollow electrode having an opening therein, another electrode presented to the interior

of the hollow electrode through said opening and having its free end terminating in the region of the opening, and means for obstructing discharge between the second electrode and the exterior of the hollow electrode, said means having a surface spaced from one of the electrodes a distance comparable to the mean free path of electrons in the space.

4. Gaseous conduction apparatus comprising electrodes received in the receptacle having a gap therebetween and one electrode having an opening extending through its surface and communicating with a space whose dimensions are greater than said gap to permit the maintenance of ionization, and means including surfaces spaced apart a distance substantially confined to the mean free path of electrons in the gas for obstructing the discharge from a part of one electrode.

5. Electrical apparatus comprising a hollow electrode having an opening therein, another electrode presented to the interior of the hollow electrode through said opening, the active area of the second electrode being confined approximately to one end thereof and to the cross-sectional area of said opening, and means for obstructing discharge between the second electrode and the exterior of the hollow electrode, said means having a surface spaced from one of the electrodes a distance comparable to the mean free path of electrons in the space.

6. An electrical apparatus comprising a gas filled receptacle, a plurality of electrodes immersed in the gas within the receptacle and having their opposing surfaces spaced in close proximity, means for producing a gaseous discharge in the space separating the electrode surfaces, and means for confining the gaseous discharge to a region entirely surrounded by electrode material.

7. A gaseous conduction rectifier comprising a sealed tube containing a hollow cathode encompassing a large free ionization space and having an opening at one side, an anode presented to the interior of the hollow cathode through said opening, and means for substantially confining the active area of the cathode to the interior thereof.

8. An electrical apparatus comprising a gas filled receptacle, a hollow electrode immersed in the gas and having a tubular portion extending inwardly into the space surrounded by the hollow electrode, a cooperating electrode having a projection extending part way into the opening formed by the tubular portion of the hollow electrode, and means for creating an electric field in the space separating the electrode.

9. A gaseous conduction rectifier comprising a tube containing a hollow cathode having a restricted opening at one side, an anode presented to the interior of the hollow cathode through said opening, and means in-

cluding said cathode for shielding the entire tube from the discharge between cathode and anode.

10. A gaseous discharge rectifier containing gas, a hollow cathode having an opening therein, another electrode presented to the interior of the hollow cathode through said opening, and means for confining the active surface of the hollow cathode to the interior thereof.

11. A gaseous conduction tube containing a hollow cathode having an opening therein, an anode presented to the interior of the hollow cathode through said opening, insulation material for supporting the cathode and anode, and means for preventing the discharge from reaching any insulation material through said opening.

12. A gaseous conduction tube comprising a hollow cathode having a restricted opening, an anode presented to the interior of the hollow cathode through said opening, and means including a member in juxtaposition to the cathode for substantially confining the current to said opening.

13. In a rectifier, a small electrode, a hollow cathode arranged with one end adjacent the other electrode and having a central ionizing space, the active area of the hollow cathode being confined to said space.

14. A tube in which the current bridges the gap between the electrodes by gaseous conduction comprising a hollow cathode formed of two parts, one part arranged to provide an ionizing pocket and one part having a restricted opening, an anode presented to said pocket through said opening, and means to confine the current to said opening.

15. An electric discharge tube comprising a hollow cathode having a restricted discharge opening, and an anode presented to the interior of the cathode through said opening, and means for confining the active area of the cathode to the interior thereof, said means providing an insulating space between the anode and the exterior of the cathode so short that the electrons passing directly across said space produce insufficient ionization to render the space conducting at potentials which produce conduction between the anode and the interior of the cathode.

16. An electric discharge tube comprising a hollow electrode having a restricted discharge opening, and a second electrode presented to the interior of the hollow electrode through said opening, and means for confining the active area of the cathode to the interior thereof, said means providing an insulating space between the second electrode and a portion of the hollow electrode surrounding said opening so short that electrons passing directly across said space produce insufficient ionization to render the

space conducting at potentials which produce conduction between the second electrode and the interior of a hollow electrode.

17. An electric discharge tube comprising  
5 a hollow cathode having a discharge opening, an anode presented to the interior of the cathode through said opening, and a tube surrounding one of the electrodes adjacent the other electrode with a space between the tube and one of the electrodes so  
10 short that electrons passing directly across the space produce insufficient ionization to render the space conducting at potentials which produce conduction between the anode  
15 and the interior of the cathode.

18. An electric discharge tube comprising a hollow cathode having a discharge opening, an anode having a surface presented to the interior of the cathode through said  
20 opening, and means for confining the active area of the anode to said surface, said means including a tube surrounding the anode adjacent the cathode with a space between the tube and anode so short that electrons passing  
25 directly across the space produce insufficient ionization to render the space conducting at potentials which produce conduction between the anode and the interior of the cathode.

30 19. A gaseous discharge tube containing a hollow cathode formed of two parts engaging around their peripheries, one part being cupped to provide an ionizing pocket and one part having a restricted opening, an  
35 anode presented to said pocket through said opening, and means surrounding the anode at the opening and extending outwardly at least approximately to the diameter of the opening to prevent discharge from the out-  
40 side of the hollow cathode.

20. A gaseous conduction device comprising a hollow cathode with an opening therein, the diameter of the opening being  
45 smaller than the interior diameter of the hollow cathode, and an anode projecting into the hollow cathode through said opening.

21. A gaseous conduction device comprising a hollow cathode with an opening therein, the diameter of the opening being  
50 smaller than the interior diameter of the hollow cathode, and an anode projecting into the hollow cathode through said opening, the space between the anode and the periphery of said opening being insulating  
55 at potentials which produce conduction between the anode and the interior of the cathode.

22. A glow-discharge tube comprising an electrode having an electron emitting surface which is solid at room temperatures,  
60 another electrode having an electron receiving surface, an obstruction between said surfaces having a restricted discharge opening, and means inside the tube for confining substantially all the current to said opening.  
65

23. A glow-discharge device comprising an electrode having an electron emitting surface which is solid at room temperatures, another electrode having an electron receiving surface, an obstruction between said surfaces  
70 having a restricted discharge opening, the anode surface lying in close juxtaposition to said opening, and means for restricting discharge between said electrodes except through said opening. 75

24. A gaseous conduction device comprising an obstruction having an opening therein, a cathode surface on one side of the opening, an anode surface presented to the cathode surface through said opening, and  
80 means obstructing discharge through the space between the obstruction and anode around said opening.

25. A gaseous discharge tube comprising an obstruction having an opening therein, a cathode surface on one side of the opening, an anode surface presented to the cathode surface through said opening, and means including a member extending outwardly  
85 from approximately the diameter of said anode surface to restrict the gaseous discharge to said cathode surface. 90

26. In a rectifier, a vacuum tube, two electrodes within said tube having their adjacent faces arranged so close together as to minimize ionization between them under one  
95 direction of applied potential, one of said electrodes having an orifice providing an ionizing path and constituting a cathode, and the other electrode constituting an anode, the diameter of the cathode being larger than that of the anode to provide an  
100 opposing face to the entire outer edge of the anode.

27. A gaseous conduction rectifier comprising a hollow cathode encompassing a large free ionization space and having an opening at one side, an anode projecting into the hollow cathode through said opening and  
105 means for substantially confining the active area of the cathode to the interior thereof. 110

28. A gaseous conduction rectifier having an arrangement of electrodes, including a hollow cathode and an anode, in which the cathode functions below the temperature at  
115 which the operation is dependent upon thermionic emission from the cathode, the active area of the cathode being sufficiently larger than that of the anode to produce gaseous conduction with a potential drop in  
120 one direction which when applied in reverse direction will not produce gaseous conduction of the same order of magnitude, and monatomic gas around the active area of the anode to reduce reverse current and anode losses. 125

29. In a half-wave rectifier, a vacuum tube, two electrodes mounted therein with their adjacent faces close together, one of said electrodes constituting a cathode having an  
130

ionizing chamber open toward the other electrode and closed at its opposite end, and means for substantially confining the discharge to said chamber.

5 30. Gaseous conduction apparatus comprising a gas-filled receptacle, an electrode immersed within the receptacle and a second electrode having an opening communicating with a restricted space to permit the formation of a space charge, and means in addition to the space charge for selectively causing electrons passing in different directions through the gas to take paths of widely different lengths.

10 31. An electrical apparatus comprising a gas-filled receptacle, closely spaced electrodes immersed therein, one of the electrodes having an opening communicating with a hollow space to allow formation of the space charge, and a conducting surface at the opening to selectively cause electrons to take paths of different lengths depending upon the direction of passage through the gas.

15 32. An electrical apparatus comprising a gas-filled receptacle, an anode and a cathode immersed therein and having opposing surfaces spaced apart a distance which is comparable to the mean free path of electrons in the gas, the cathode being provided with an opening communicating with a hollow space to permit formation of a space charge, and a conducting surface placed opposite the opening to limit the paths of electrons passing from the anode to the cathode to distances which are sufficiently short to prevent ionization.

20 33. An electrical apparatus comprising a gas-filled receptacle, an anode, a cathode having a surface provided with an opening and spaced from the surface of the anode a distance which is short and comparable to the mean free path of electrons in the gas, a sleeve surrounding the opening to pro-

vide a passage communicating with a gaseous region adapted to permit the formation of a space charge of positive ions upon impressing an electric field between the anode and the cathode, and a conducting surface placed near the end of the passage.

25 34. A gaseous conduction rectifier comprising an anode, and a cathode whose active area is sufficiently larger than that of the anode to produce gaseous conduction with a potential drop in one direction which when applied in reverse direction will not produce gaseous conduction of the same order of magnitude, and means for confining the discharge to said active areas including surfaces spaced apart appreciably but insufficiently to permit substantial ionization by electrons traveling directly across the space therebetween.

30 35. A gaseous conduction rectifier having an arrangement of electrodes, including a hollow cathode and an anode, in which the cathode functions below the temperature at which the operation is dependent upon thermionic emission from the cathode, the active area of the anode being small in relation to the total area of the body of conducting material in conductive relation to the said active area in the rectifier.

35 36. A gaseous conduction rectifier comprising a non-incandescent cathode, an elongate anode having one end presented to the cathode, and means for confining the active area of the anode to the tip of said end.

40 37. A gaseous conduction rectifier having an arrangement of electrodes in which the back current is limited chiefly by space charge at the anode, the anode comprising a body, the active area of which is small in relation to the total area of the body of conducting material in conductive relation to said active area.

CHARLES G. SMITH.

June 14, 1927.

1,632,578

F. BAHR

ARC LAMP OF THE SEALED TYPE

Filed Feb. 21, 1924

Fig. 1

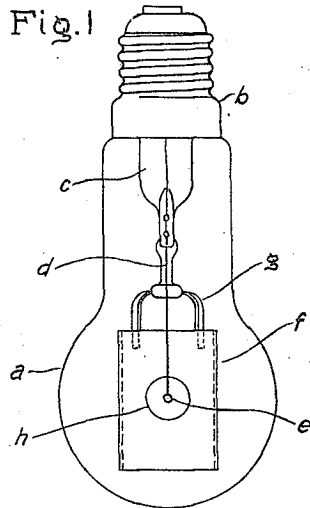


Fig. 2

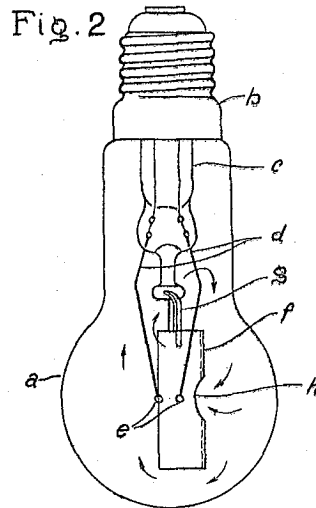


Fig. 3

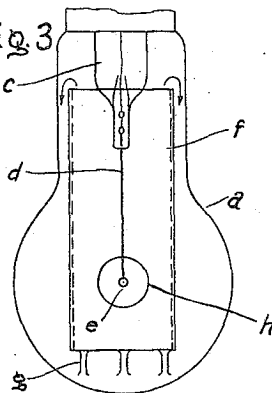


Fig. 4

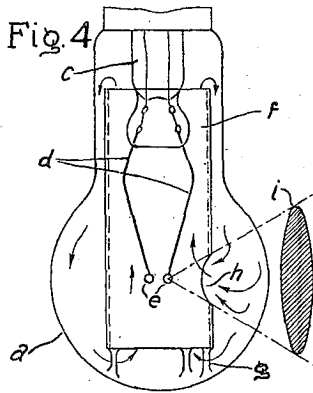


Fig. 5

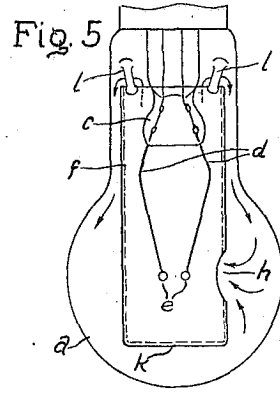


Fig. 6

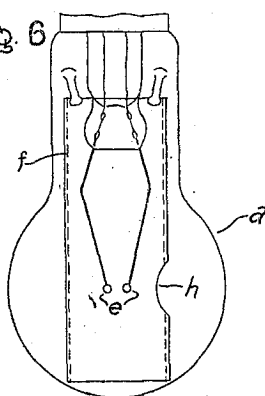


Fig. 7

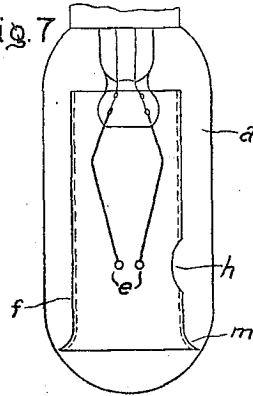
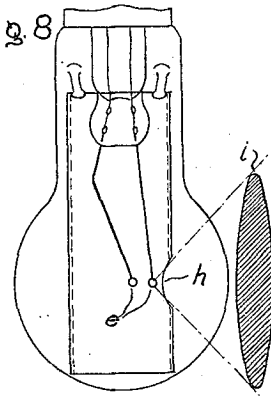


Fig. 8



Inventor  
Fritz Bahr  
by *Alexander S. Funt*  
His Attorney

# UNITED STATES PATENT OFFICE.

FRITZ BAHR, OF CHARLOTTENBURG, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## ARC LAMP OF THE SEALED TYPE.

Application filed February 21, 1924, Serial No. 694,406, and in Germany May 4, 1923.

My invention relates to arc lamps and more particularly to arc lamps of the sealed type, a type of which is the tungsten arc lamp. Lamps of this type have been suggested for use for projection purposes. When so used, the lamp should be placed as close as possible to the lens if the necessity of a particularly large condensing lens is to be avoided. The tungsten arc lamps which have been heretofore provided were rather small, being in size smaller than the incandescent lamp. This small type had the objection that the bulb would become blackened very considerably after a comparatively short burning period.

One of the objects of my invention is to overcome this difficulty by providing a special screen internally located in the bulb, the electrodes being located behind or within the screen. This screen is provided with an opening opposite the electrodes between which the arc is formed. With this arrangement, a draft is created toward the opening in the screen by the gas filling in the bulb which becomes heated when the lamp is running. This current flows through the opening toward the electrodes and upwardly through the screen which serves as a conducting chimney. The gas current, thus flowing counteracts or opposes the metal vapors or metal particles ejected from the neighborhood of the arc and prevents these vapors or particles from reaching the glass wall of the bulb through which the rays must pass out of the bulb. Therefore, the bulb is kept free from blackening in the regions through which the rays must pass in order to reach a condensing lens, screen, or other equipment.

One of the objects of my invention is to provide a screen which may be given a chimney-like form and which may surround the electrodes as a jacket. With such a provision, the evaporated electrode material can deposit, in the main, on the interior of this jacket. The flow of the gas through the opening in the jacket toward the interior can be very materially increased by having the lower ends of the jacket closed. Therefore, the jacket may engage the lower wall of the bulb and be fused to the latter. The opening in the jacket is made so that the condensing lens is completely covered by a cone of light. The size of the slot angle formed by the light can be varied by chang-

ing the distance of the electrodes from the opening. If desired, these electrodes can be mounted eccentrically in the bulb and in the jacket.

It is also an object to provide other details of improvement tending to increase the efficiency and serviceability of a lamp of the above character.

To accomplish the foregoing and other useful ends, I provide means hereinafter more fully described and claimed in connection with the accompanying drawing wherein different practical designs of the lamp, according to the invention, are shown.

Figs. 1 and 2 show a tungsten lamp with the screen mounted in front of the electrodes, Fig. 2 being taken as a side view of Fig. 1.

Figs. 3 and 4 show two similar views of a design in which the electrodes are surrounded by a chimney-like jacket.

Figs. 5 through 8 illustrate other forms of the lamp having chimney-like jackets.

The lamp shown in Figs. 1 and 2 comprises a small incandescent lamp-like bulb *a*, which is provided with a base *b*, of the usual type. Through the stem *c*, the lead-in wires *d* are brought into the lamp to the spherical electrodes *e*. The electrodes are surrounded by the screen *f*. This screen may be fastened in position in any suitable manner as for example by means of the wires *g*. At the level of the electrodes *e*, the screen *f* is provided with an opening *h* which permits rays of light from the lamp to pass freely outward. By the screen *f* the gas filling which is heated when the lamp burns, is directed, as indicated by the arrows. As the arrows indicate, the gas is drawn in through the opening in the screen *f* through which the rays pass out. This current prevents the expelled particles of metal from depositing on that portion of the bulb which comes within the cone of light.

The screen can be of any suitable shape. It can be made of a flat plate, for instance. However, as shown in Figs. 3 and 4, the screen is advantageously given the form of a cylinder-like jacket *f* which surrounds the electrodes and which is fastened or fused to the bulb *a* by means of small feet *g*. The draft of the current is of course intensified by the chimney-like jacket and at the same time, the circuit of the current is caused to follow certain paths so that the metal par-



articles are deposited mainly within the jacket so that even the bulb as a whole remains entirely free from deposit for some time after the lamp is put into operation. The opening *h* in the screen is advantageously made of such dimensions that the condensing lens *l* of the projection device comes entirely within the cone of light on the lamp.

As shown in Fig. 5, the protective jacket *f* can be closed at its lower end by a plate *k* and fastened to the bulb at the upper end by the supporting arms *l*. By this arrangement, the flow of gas filling through the lower opening of the jacket as shown in Fig. 4, can be eliminated and the flow of gas through the passage opening *h* can be intensified considerably. Furthermore, the protective jacket *f* can be made as long as shown in Fig. 6, so that its lower rim may rest against the wall *a* of the bulb. In this case, the jacket is closed directly by the bulb and of course need not be closed by a special plate such as the plate *k* in Fig. 5.

The protective jacket can be also provided with a turned out rim *m*, Fig. 7, which may be fused to the bulb so that the latter closes off the jacket as in Fig. 6.

As shown in Fig. 8, the electrodes *e* can be arranged eccentrically with respect to the bulb *a* and the jacket *f* in such a manner that the electrodes will be located closer to the opening *h*. With this arrangement, the solid angle of the light cone is increased so that a larger condensing lens could be used. The contrast between the two arrangements can be appreciated by comparing Figs. 4 and 8. The screen or jacket can be fastened in the lamp in any suitable manner and this screen may be made of glass, but it may also be made of other material, such as mica, or even metal.

In view of the disclosure, it is obvious that my invention may be applied in other forms which will readily suggest themselves and therefore I do not wish to be limited to any particular construction other than that falling within the scope of the claims appended hereto.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an electric lamp, the following elements in combination, a source of light sealed within an envelope, said envelope having a gas enclosed therein, a tube, said source located within said tube, an opening in said tube, said elements so disposed as to create a draft of said gas through said opening for preventing the passage of emanations from the light source through said opening, said tube vertically disposed and having said opening at the side and having also an opening at the top with the

lower end closely whereby the said draft after passing through said opening, passes out through said top opening.

2. In a tungsten arc lamp with an arc surrounded by a sealed envelope, said envelope having a gas therein, said arc enclosed by a screen within the envelope for cutting off emanations from the light source, a hole in the side of said screen through which a beam of light may pass, said elements so disposed as to create a draft through said opening to prevent emanations from passing through said opening and darkening the envelope about the region through which said beam passes through the envelope.

3. A tungsten arc lamp comprising electrodes in a sealed envelope containing a gas and comprising also a shield between the electrodes and the envelope for preventing emanations from the electrodes from darkening the envelope, and an opening in the shield for permitting rays of light from the arc to pass through, said opening so located with reference to the arc electrodes that circulation of the gas within the envelope takes place through the opening toward the electrodes to oppose the passage of emanations from the electrodes through the opening toward the envelope.

4. In a lamp, a sealed envelope, a pair of electrodes between which an arc is adapted to be established, said lamp having in combination a solid screen about the electrodes for preventing emanations from the electrodes from striking the envelope, an opening in said shield to permit rays of light from the arc to pass through, and a gas in said envelope serving as a shield to oppose the passage of emanations from the arc through said opening and striking the envelope, said opening being so disposed with respect to the electrodes as to promote a circulation of the gas through said opening toward said electrode.

5. An electric lamp comprising a light source within a sealed envelop, said envelop containing a gas, said lamp comprising also a shield within the envelop, said shield being located between the light source and the envelop for preventing emanations from the light source darkening the envelop, and an opening in the shield for permitting rays of light from the light source to pass there-through said opening being so located with reference to the light source that circulation of the gas takes place through the opening toward the light source to oppose the passage of emanations through the opening toward the envelop.

In witness whereof I have hereunto set my hand this 28th day of January, 1924.

FRITZ BAHR.

Nov. 20, 1928.

1,692,413

W. T. LEWIS

THERAPEUTIC LAMP

Filed May 21, 1927

Fig. 1

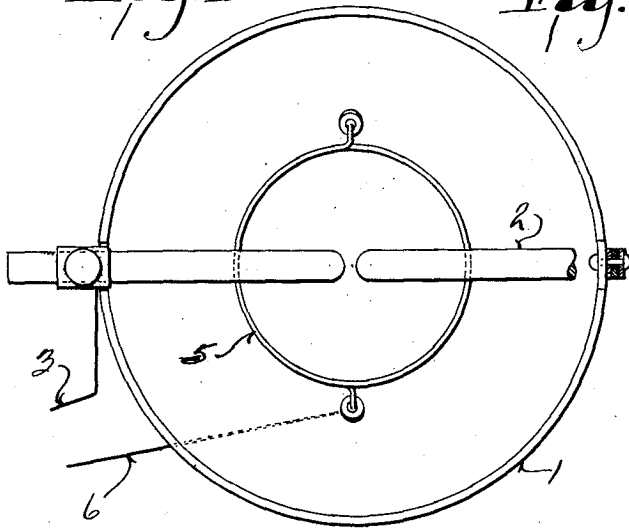


Fig. 2

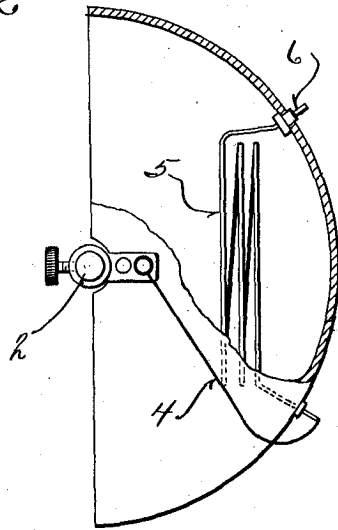


Fig. 3

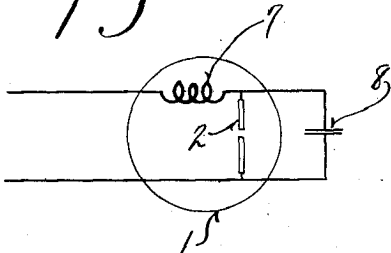


Fig. 4

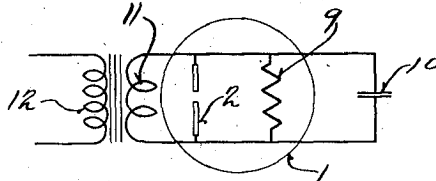


Fig. 5

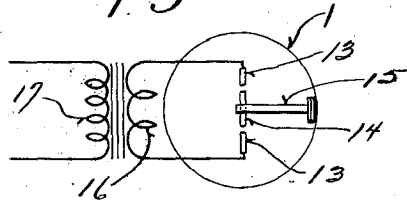
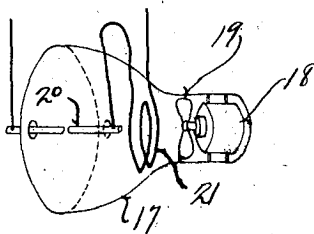


Fig. 6



Inventor

William Turner Lewis

By *Chas. H. Lewis*  
Attorneys

# UNITED STATES PATENT OFFICE.

WILLIAM TURNOR LEWIS, OF RACINE, WISCONSIN, ASSIGNOR TO WESTERN COIL & ELECTRICAL COMPANY, OF RACINE, WISCONSIN.

## THERAPEUTIC LAMP.

Application filed May 21, 1927. Serial No. 193,244.

This invention relates to therapeutic lamps.

In therapeutic lamps, particularly those for giving ultra-violet light treatments, it is the usual practice to provide a rheostat which is located on the floor or at a remote point to the lamp or holder, so as to control the lamp to prevent excessive current from flowing from the line to the lamp. This rheostat necessarily wastes a large amount of energy which is wholly useless, and it is absolutely essential in these lamps to provide a resistance element as otherwise there would be times when a dead short circuit would be produced across the line.

This invention is designed to overcome the defects noted above and objects of this invention are to provide a novel form of therapeutic lamp in which the entire energy is utilized in the production of effective and active rays which are thrown directly from and reflected from the lamp upon the patient, so that all of the energy is utilized in the production of useful rays.

From extensive experiments, it has been found that the therapeutic effect from ultra-violet light is very much enhanced by the presence of the infra-red and red rays as the infra-red rays produce a marked hyperæmia or drawing of the blood to the surface. Thus, more blood is exposed to the beneficial action of the ultra violet rays when strong infra-red rays accompany the ultra-violet rays. In addition to this, that the effect from the ultra-violet light is enhanced when the surface of the body, upon which it falls, is warmed.

This invention takes advantages of the discovery noted above and has for its further object the production of ultra-violet and infra-red rays in a therapeutic lamp so constructed that both of these groups of rays are projected upon the patient and the therapeutic effect of the ultra-violet rays is thus markedly increased.

Further objects are to provide a very simple and practical type of therapeutic lamp embodying the features noted above which may be as freely used by physicians and others as the lamps heretofore known.

Further objects are to provide a novel form of therapeutic lamp having the characteristics noted above, in which means are provided

for rapidly drawing the air through the lamp to thus prevent the accumulation of powdered carbon or other sediment on the walls of the reflector, and also to draw all sparks or heated minute particles away from the lamp so that they cannot fall upon the patient.

The reflectors for lamps having both the heat generating means and the electric arc are subjected to intense heat and are in contact with the air, and it is therefore a further object of this invention to provide a reflecting coating which will not be injured by any of the effects noted above and which is extremely hard and will last a great length of time.

Embodiments of the invention are shown in the accompanying drawings in which:

Figure 1 is a face view of one form of lamp with parts broken away;

Figure 2 is a side elevation partly in section of the structure shown in Figure 1;

Figure 3 is a diagrammatic view showing a further form of the invention;

Figure 4 is a diagrammatic view showing a still further form of the invention;

Figure 5 is a diagrammatic view showing the use of series arcs cooperating and replacing the control resistance;

Figure 6 is a diagrammatic view of a further modified form in which a small electric fan is incorporated in the lamp for causing a rapid current of air to flow through the lamp to draw all dislodged particles therefrom.

Referring to Figures 1 and 2, it will be seen that the lamp comprises a reflector which carries a pair of carbons or other electrodes 2 between which the arc is formed. These carbons may be carried in any suitable manner and one form only of a holder for adjustably carrying the carbons has been shown. It is within the province of this invention to use any type of holder desired, whether manual or automatic. As the particular form plays no part in this invention it has not been developed in detail. One of the carbons is connected by means of a conductor 3 to one of the mains and the other carbon is connected by means of a conductor 4 to one end of a resistance element or heater 5. This heater element may be formed of any suitable high resistance material and may be mounted in any desired manner, by winding it upon a suitable

refractory form, or else by suspending it within the reflector. The other end of the resistance element or heater is connected by means of the conductor 6 with the other main.

5 In Figure 3, substantially the same idea is developed. However, in this form, the heater element is coiled and acts somewhat in the nature of an inductance, as indicated by the reference character 7. It is mounted within  
10 the reflector 1 as well as the carbons 2. It is to be noted that the inductance 7 has some resistance which acts as a check to the current flow to the lamp and also the fact that an inductance prevents sudden surges of current from  
15 the line to the lamp. It thus serves in the double capacity of a heater and a control device.

It has been found that a large current flow through the arc produces a very much hotter  
20 arc and also causes the carbons to burn into pointed tips. However, this increased consumption is not necessary in the production of an intensely hot arc as has been found by experiments with this lamp. As shown in  
25 Figure 3, a condenser 8 is bridged across the arc or otherwise connected in the circuit. This condenser changes the characteristics of the arc, although it does not greatly increase the current consumption of the lamp. It has  
30 been found that with an electrostatic condenser, approximately sixty microfarads, for example, that an intensely hot arc is produced without any great increase in current consumption. The presence of the condenser, it  
35 is believed, superimposes a high frequency alternating current upon the direct or alternating current supplied the arc. At all events, the practical and net results of this construction is that a very much hotter arc  
40 is produced without any great increase in current consumption.

In the form of the invention shown in Figure 4, a noninductive resistance element 9 is mounted within the reflector together with  
45 the carbons 2, and a condenser 10 is bridged across the arc. The lamp is supplied by the secondary 11 of a transformer whose primary 12 is supplied from the city mains.

In the form shown in Figure 5, the reflector carries two series arcs which are formed by outer carbons 13 and an intermediate or central carbon 14 held by a suitably insulated bracket 15. This lamp may be supplied in any suitable manner as, for example,  
55 from the step-down secondary 16 of a transformer, the primary 17 being connected with the city mains.

In this last form of the invention, the two arcs in series avoid the necessity of a resistance connected in the circuit of the arc. One of the arcs, for example, may materially decrease in resistance, but nevertheless the other arc may maintain the total resistance of the circuit and thus damage can not occur.

65 In addition to this feature, the central car-

bon does not have a chance to cool off as rapidly as the outer carbons which are carried in their holders. The central carbon, therefore, becomes very hot and acts as a source for red and infra-red rays. 70

In the form shown in Figure 6, a different type of reflector, such as shown diagrammatically and indicated by the reference character 17, is employed. This reflector is open at its front and back and its rear reduced portion  
75 houses a small electric motor 18 provided with a fan 19 adapted to draw the air rearwardly and thus produce a rapid and strong blast of air through the lamp. This blast of air takes away all carbon dust or other material that may fall from the carbons 20 and carries it rearwardly from the lamp. Further than this, all sparks that may be produced by the lamp arc drawn rearwardly and projected from the lamp and thus can not  
85 fall upon the patient. Any form of heater, such, for example, as indicated by the reference character 21, may be employed in connection with the arc in the manner described in detail for the other forms of the  
90 invention.

Although I do not intend limiting this invention to the specific mode of operation or principle which I believe is effective in producing the results discussed hereinafter, nevertheless I believe that the results produced by this apparatus or its mode of functioning are substantially as follows: 95

The infra-red and red rays appear to enhance the penetrating qualities of the ultra-violet rays, or at all events, materially increase their therapeutic effect. 100

It seems that these rays make it easier for the ultra-violet rays to get in their work and, in addition to this, the infra-red rays warm  
105 the surface of the body and make it more responsive to the effect of the ultra-violet rays. From actual experiments conducted with this lamp, it has been found that the time of exposure needed for producing the certain definite therapeutic effect may be lessened at least twenty-five percent. 110

When it is considered that these therapeutic lamps generate a great amount of heat and also house an electric arc, it is apparent that unusual demands are made upon the reflectors. The reflectors are plated with chromium which is extremely hard and will resist chemical change due to the action of the air or the fumes from the arc light even when  
115 in its highly heated condition. Thus, by the use of a chromium reflecting surface, absorption at such surface even after long use is materially reduced.

In the description and claims, it is intended that the expression "infra-red" be interpreted as meaning not only strictly infra-red rays, but also infra-red rays when combined with rays in the red portion of the visible spectrum. It is also to be understood that this expression 125 130

is used to cover the rays emitted by the resistance either when at visible red heat or when below this point.

5 It will be seen that a novel form of therapeutic lamp has been provided in which all of the energy is utilized in producing useful, curative rays which may be projected upon the patient's body and which will be effective in securing the desired results.

10 Further, it will be seen that the lamp is substantially fool-proof and may be handled by others than those skilled in the electrical science with the utmost safety.

15 It will be noted further that the lamp is very simple and embodies a new principle discovered by extensive experiments.

20 Although the invention has been described in considerable detail, such description is intended as illustrative rather than limiting as the invention may be variously embodied and as the scope of such invention is to be determined as claimed.

25 It is to be distinctly understood that although the apparatus has been described as particularly designed for the treatment of human beings that obviously it may be used for the treatment of plants, animals, or other organic bodies without departing from the scope of the invention. It is, therefore, understood that the term "patient" or similar terms, are to be construed broadly as outlined immediately above.

30 It is to be distinctly understood that other materials than chromium may be used for coating the reflectors, although chromium is

the material preferred, and except where definitely stated in the claims, the construction of the reflectors may be varied within the scope of such claims.

I claim:

40 1. A therapeutic lamp comprising a reflector, an arc light mounted therein, a heater mounted within said reflector and connected to said arc light, and means for producing a blast of air through said reflector from the front to the rear, whereby particles falling from said arc light are projected from the rear of said reflector and are prevented from accumulating upon said reflector. 45

2. A therapeutic lamp comprising a reflector having an inner surface formed of chromium, means for generating ultra violet rays, and means for generating infra-red rays, both said means being mounted within said reflector. 50 55

3. A therapeutic lamp comprising a chromium lined reflector, an arc light mounted therein, and a source of infra-red rays mounted within said reflector, whereby both infra-red and ultra-violet rays are projected from the said lamp. 60

4. A reflector for a lamp subjected to the action of heat and air, said reflector comprising a metal body portion provided with a reflecting surface formed of chromium. 65

In testimony that I claim the foregoing I have hereunto set my hand at Racine, in the county of Racine and State of Wisconsin.

WILLIAM TURNOR LEWIS.

March 19, 1935.

C. T. CROCKER

1,995,144

ARC LAMP

Filed Dec. 6, 1929

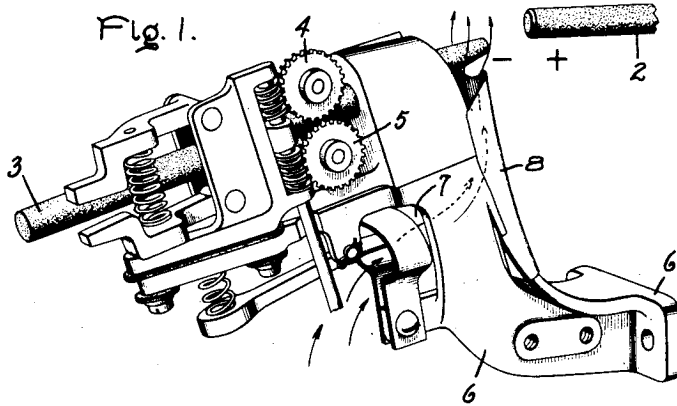


Fig. 2.

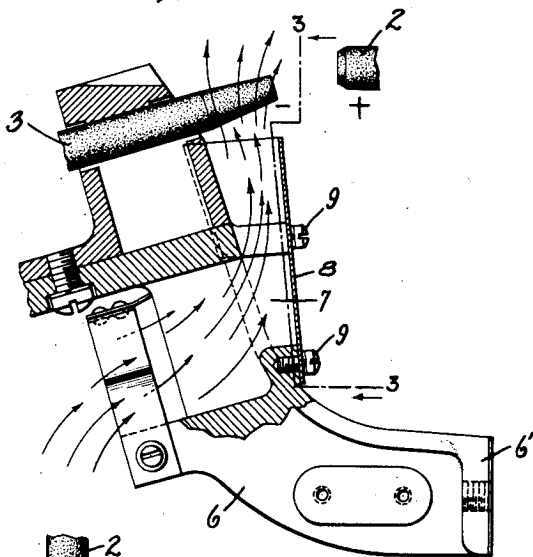


Fig. 3.

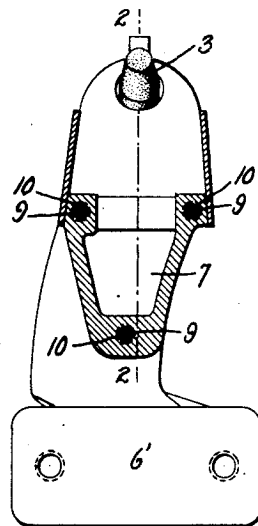
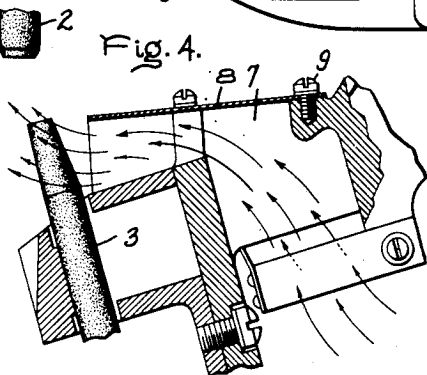


Fig. 4.



Inventor:  
Clarence T. Crocker  
by *Charles E. Tuller*  
His Attorney.

# UNITED STATES PATENT OFFICE

1,995,144

## ARC LAMP

Clarence T. Crocker, Schenectady, N. Y., assignor  
to General Electric Company, a corporation of  
New York

Application December 6, 1929, Serial No. 412,256

1 Claim. (Cl. 176—51)

My invention relates to arc lamps. More particularly it relates to arc lamps which are especially adapted for searchlight work, such as, for example, projecting a beam overhead for locating an airship.

Prior to my invention it was found that when a searchlight of the above character was pointing upward at a steep angle, such as, for example, from 45 to 90° with the horizontal, and kept so for a considerable length of time, the beam no longer remained constant, but periodically fluctuated, causing a very serious and substantial variation in the intensity of the beam. These fluctuations were found to recur sometimes at short intervals of a minute more or less and sometimes at intervals from one-quarter to one-half hour, and of even longer duration.

While during normal operation of the lamp one end of the arc is confined more or less to the end of the positive electrode, I have observed that during the fluctuations mentioned a change takes place in the arc during which the arc is no longer confined to the terminal of the positive electrode but has a tendency to spread back of the positive terminal, under it and toward the head of the positive electrode holder. This operation is sometimes referred to as "under-burning". I have also observed that at such time the shape of the terminal section of the negative electrode is no longer normal, but has become distorted with respect to the axis of the negative electrode. For example, the negative electrode sometimes forms a heel considerably below the axis of the electrode from which the streams of the under-burning arc appear to emanate toward the under side of the positive electrode. I find that this action of the arc, which seriously interferes with the effectiveness of the searchlight beam, may be overcome by directing a draft of air or other electrode oxidizing gas against the terminal of the negative electrode. I accomplish this, for example, by mounting the negative electrode over a draft-producing structure.

It is an object of my invention to provide means such as above indicated for preventing under-burning, for maintaining the normal operation of an arc lamp under any inclination of the axis of the searchlight beam whether it be horizontal or whether the inclination be as high as 90° with respect to the horizontal, and for maintaining the negative electrode terminal substantially symmetrical in shape with respect to the axis of the electrode.

The features of my invention will be better understood from the following specification and

claim, reference being had to the accompanying sheet of drawing in which Fig. 1 shows in perspective the positive and negative electrodes of an arc lamp in normal condition and operating relation, the lamp being in position for a horizontal beam. In this figure the negative electrode is shown secured to its support or holding structure, which structure embodies the feature of the invention. Fig. 2 shows the same electrodes and supporting structure as Fig. 1 in the same position, the drawing being shown in elevation and partly in section, the section being taken along an axial plane of the negative electrode, that is, along a plane through line 2—2, Fig. 3. Fig. 3 shows the negative electrode, its supporting structure and a portion of the flue in front elevation and partly in section, the section being taken along the line 3—3, Fig. 2. Fig. 4 is a drawing similar to that of Fig. 2 with the lamp in position for projecting a vertical beam.

Referring more in detail to the drawing, the positive and negative electrodes 2 and 3 respectively are represented in the various figures as being in their normal condition and relation. It will be understood, however, that the reflecting means, the drum and the tilting mechanism for raising and lowering the beam along a vertical plane are not shown, such means being of any suitable well known type. In the drawing, the positive head for holding the positive electrode 2 has not been shown. It will be understood that any suitable form of head in common use is contemplated. The negative electrode is shown held by the usual feed mechanism comprising the feed rollers 4 and 5. The feed mechanism is supported by the arm 6, which latter may be secured in any suitable manner to the frame of the arc lamp. For this purpose the perforated flange 6' is provided. This arm is provided with a cavity in the form of a channel 7, which channel extends behind the plate 8 and along the front of the arm 6 toward the negative electrode. The plate 8 may be secured to the frame of the support in any suitable manner, such as, for example, by means of bolts 9 which engage the threaded holes 10. With this arrangement it will be seen that a draft conducting means or flue is provided from the under side of the arm 6 up to or in proximity of the forward terminal of the negative electrode. A draft, therefore, will flow from the under side of the support through the channel 7, which draft is indicated by the group of arrows, Figs. 2 and 4. This draft bathes the terminal section of the negative electrode next to the arc.

The type of arc lamp indicated in the draw-

ing is that known as the high intensity arc lamp, in which the electrodes are usually arranged at an angle with respect to each other. In this type of lamp, one type of which is shown in U. S. Patent 1,086,311, the arc usually produces a tail which extends upwardly from the terminal of the positive electrode. The draft, therefore, when it strikes the negative electrode bathes the terminal section of the negative electrode and after crossing the axis of the positive electrode merges with the tail of the arc.

It will be understood that while I have elected to illustrate my invention in connection with a specific form of apparatus illustrated in the drawing, I do not wish to be so limited inasmuch as I contemplate modifications and variations within the spirit of the invention and scope of the claim contained herein.

What I claim as new and desire to secure by Letters Patent of the United States is:

In an arc lamp, the combination of a negative carbon, a support therefor which is adjustable to hold said carbon in a substantially horizontal or a substantially vertical position, means for directing a stream of air against the operating end of said carbon comprising a draft flue attached to said support having its discharge end directly adjacent the operating end of said negative carbon and having its intake end below said support and in back of said operating end whereby the intake end of said flue is below said discharge end at both the horizontal and the vertical positions of said carbon.

CLARENCE T. CROCKER.



Oct. 19, 1937.

L. BURNS  
GAS OR VAPOR ARC DISCHARGE LAMP

2,096,704

Filed July 17, 1935

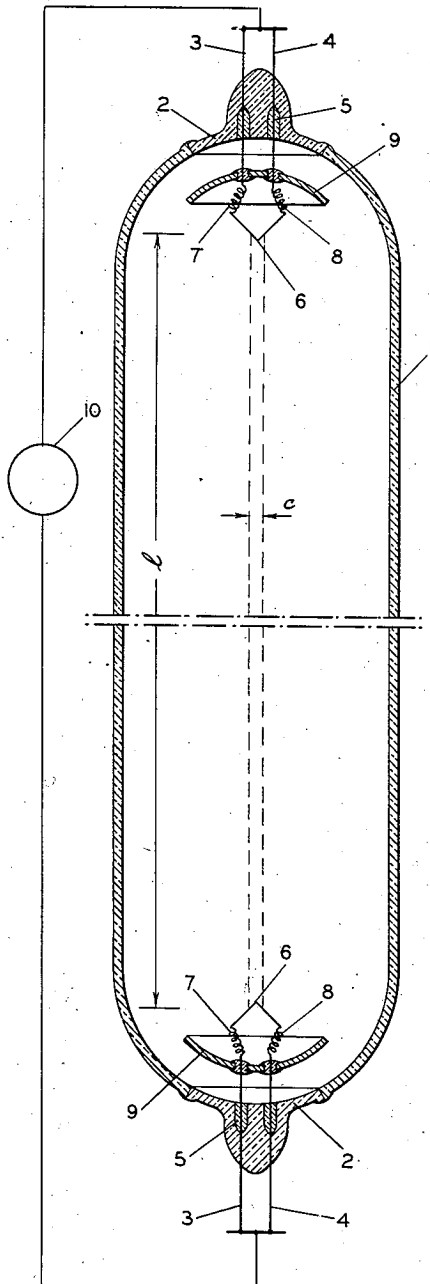


Fig. 1.

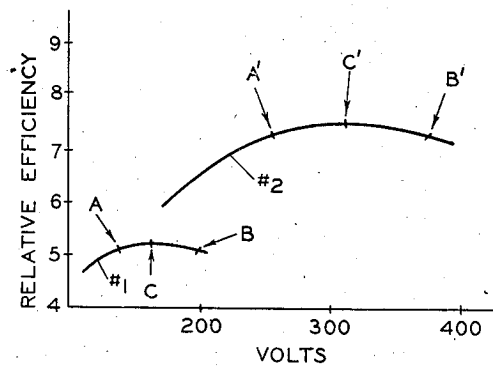


Fig. 2.

Lawrence Burns  
INVENTOR

BY John J. Rogan  
ATTORNEY

# UNITED STATES PATENT OFFICE

2,096,704

## GAS OR VAPOR ARC DISCHARGE LAMP

Laurence Burns, Revere, Mass., assignor to Hygrade Sylvania Corporation, Salem, Mass., a corporation of Massachusetts

Application July 17, 1935, Serial No. 31,754

3 Claims. (Cl. 176—124)

This invention relates to electric lamps and with particularity to lamps of the type employing a filling of ionizable medium for maintaining a luminous arc-like discharge therethrough.

A principal object of the invention is to provide a lamp of the arc-like discharge type which has a maximum of arc-flame stability.

As pointed out in application Serial No. 24,991 filed June 5th, 1935, one of the causes of loss of luminous efficiency in arc-discharge lamps is the tendency of the arc-flame to bow outwardly and away from the central longitudinal axis of the enclosing envelope. This tendency to bow is a function of the convection currents within the gas or vapor filling. I have found that the positional stability of the arc may be maintained by proper proportioning of the length of the arc to the arc current or to the arc cross section. Accordingly another object of the invention is to provide an arc-discharge lamp which is designed to have a definite relation between the arc current or cross section and the length of the arc.

Another object is to provide an arc-discharge lamp which operates with a relatively high pressure filling and which is so designed as to produce a predetermined ratio of arc length to arc cross section at which the arc has maximum positional stability.

A feature of the invention relates to an arc-discharge lamp of the type operating at relatively high pressure of the ionizable filling between electrodes arranged to strike an arc confined substantially to the central or axial portion of the enclosing envelope, the electrical and mechanical parameters of the lamp being so chosen that the arc maintains its central position with very little tendency to "wobble" or positional instability.

A further feature relates to the novel organization, arrangement and relative proportioning of parts which go to make up an improved and highly efficient lamp of the high pressure arc-discharge type.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed description and the appended claims.

While the invention will be described herein as embodied in one particular type of lamp envelope and with certain types of electrodes, it will be understood that this is done merely for purposes of explanation and not by way of limitation. In the drawing,

Fig. 1 represents a typical form of arc-discharge lamp embodying features of the invention.

Fig. 2 shows a series of curves for explaining certain aspects of the invention.

Referring to Fig. 1 of the drawing there is shown in diagrammatic form, a lamp having an enclosing envelope or main body portion 1 of substantially cylindrical shape and preferably of a refractory transparent material such as glass combustion tubing. The body portion 1 is closed off at the ends by concave cap portions 2 of a softer grade of glass and through which the lead-in wires 3, 4 are sealed preferably through the intermediary of softer glass beads 5. Supported on each pair of lead-in wires is an electrode preferably formed of refractory material such as tungsten, molybdenum or the like provided with a forward pointed or V-shaped section 6 joined to the lead-in wires through coiled or zig-zag sections 7, 8. As disclosed in application Serial No. 24,991 the sections 7, 8 are preferably disposed within the angle subtended by the V-shaped section so that the latter section shields the sections 7, 8 from a migrating discharge. The entire electrode, or if desired only the V-shaped section, is coated with suitable electron-emissive material such for example as the oxide or oxides of the alkaline earths and the electrodes are so mounted that the points are in alignment preferably on the longitudinal axis of the envelope 1. If desired a shield 9 may be positioned in back of each electrode for purposes set forth in detail in application Serial No. 23,992 filed May 29th, 1935. After being suitably evacuated and degasified in accordance with accepted lamp procedure, the enclosing envelope is provided with a filling of an ionizable medium or mediums such for example as a filling of mercury vapor and an inert gas such as argon or mixture of inert gases to facilitate starting. If desired the lamp proper may be enclosed within an outer jacket either evacuated, open to the air, or filled with a gas for the purpose of conserving the heat within the ionized filling when the lamp is in use.

With the type of lamp described, when a suitable voltage is impressed across the electrodes, a glow discharge starts in a similar manner to the starting of a glow from thermionically inactive electrodes, but the passage of this glow current serves to raise the electrodes to a temperature at which they function mainly as thermionic emitters. When this condition is attained the discharge between the electrodes is arc-like in character and is characterized by a small electrode drop approximately 15 volts. This preliminary arc occurs in the argon or other inert gas filling and the heat of this arc gradually warms the en-

closing envelope and the vapor filling so that the pressure of this vapor rises and the envelope becomes filled with the characteristic blue color of a low pressure mercury discharge. Under this latter condition the arc drop is of the order of from 10 to 30 volts or more depending upon the longitudinal separation of the electrodes. As the heat of the discharge rises, the voltage across the lamp also rises and the light emitting column shrinks to a diameter smaller than that of the envelope *l*, becoming more and more constricted as the density of the vapor increases. When the vapor density reaches a certain value for a given size of envelope the arc column will have a tendency to "bow" outwardly from the central portion of the envelope. When the lamp is used in a vertical position this "bowing" phenomenon is most pronounced at the bottom electrode and is probably caused by the convection currents in the vapor and gas filling. When the lamp is in operation the arc flame temperature is of the order of 6000 degrees centigrade, while the temperature of the envelope is of the order of 600 degrees centigrade. Because of this temperature gradient from the central part of the envelope to the wall, the vapor will tend to rise near the arc flame, and return again along the wall *l*. Any slight defect in the centering of the arc column will have an exaggerated effect on the convection currents, with resultant increased tendency of the arc to bow or "wobble". The positioning of the electrode discharge surfaces along the central axis of the envelope reduces this tendency to positional instability of the arc. Furthermore in the high pressure stage of the lamp's operation the discharge proceeds from a very restricted area of each electrode, and with the shape of electrode shown in the drawing, this discharge is confined substantially to the points *g*.

As the vapor density is further increased, a point is reached where the arc column begins to move around appreciably within the envelope *l*. In some cases this positional instability reaches such an amplitude and occurs at such a frequency as to extinguish eventually the arc itself, that is, the column moves enough to break itself, this phenomenon also being a function of the convection currents in the vapor. I have found that in the lamp as described, convection will take place smoothly in streamlines, resulting in so-called "lamellar" flow when the lamp is designed to produce an arc column having a certain ratio of arc length to arc current or to arc cross section. I have also found that the factor which determines the amount of positional instability in the arc column is not vapor density alone, but that the geometry of the discharge tube and the electrical constants of the discharge are very important. For example a relatively low power lamp such as a 400 watt input lamp, may be quite stable at a density corresponding to atmospheric pressure; but a higher power lamp, for example one of 2000 watts may exhibit decided "wiggling" or positional instability at half that density. On the other hand I have found that for a constant density, a lamp may have serious positional instability at one arc current, for example 5 amperes, and substantially negligible instability at a higher current, for example 10 amperes. After numerous experiments I have found that the tendency to "wobble" or positional instability decreases in proportion to the increase of arc current, and is probably due to a widening of the arc column. Furthermore I have found that the longer the arc column a proportionately

greater current is required for a given arc stability. For operating pressures of the order of an atmosphere I have found that approximately one-half ampere is required for each inch of arc length, and this ratio with slight modification holds for even lower pressures down to as low as one-half atmosphere and as high as one-and-one-half atmospheres. Preferably however where the operating pressure of the ionizable filling is materially less than one atmosphere the arc should have a diameter of the order of at least 0.025 inch for each inch of arc length.

I have also found that for a given lamp size and with a given power input the luminous efficiency rises very rapidly with increasing voltage until the vapor density reaches a certain value, then remains relatively uniform throughout a range of densities, and as the vapor density continues to rise beyond this range, the luminous efficiency falls relatively rapidly. Thus there are shown in Fig. 2 characteristic curves of two lamps showing the relation between the variation of voltage across the lamp and the corresponding variation in luminous efficiency. Curve #1 is typical of a relatively low power lamp for example one designed to operate with a power input of approximately 400 watts while curve #2 represents a lamp of about 2000 watts input. From curve #2 it will be seen that for voltages below 200 volts the luminous efficiency of the larger lamp is very low but rises gradually to a maximum at approximately 300 volts. In the range between approximately 250 and 350 volts the luminous efficiency remains relatively uniform. As the voltage is increased above 350 volts there is a sudden decrease in efficiency and in the region where the efficiency starts to fall rapidly as indicated by the letter B, there is a pronounced tendency for the arc to "wobble" or bow excessively. In the 400 watt lamp the efficiency gradually rises to a maximum at about 180 volts and in the range between 140 volts and 210 volts the efficiency is quite uniform. As the voltage is increased above 200 volts the efficiency drops off, and the arc wobble becomes quite pronounced. In the case of the lamp represented by curve 1 the point A corresponded approximately to a vapor density of about 0.75 atmosphere while in the case of the lamp represented by curve 2, the point A' corresponded approximately to a vapor density of about 0.5 atmosphere. The point B on curve 1 corresponded to a vapor density of about 1.0 atmosphere or approximately 0.002 gram per cubic centimeter, while the point B' corresponded to about 0.75 atmosphere. Generally speaking therefore the lamps whether of the high or low power input type exhibit their highest luminous efficiencies in the region below that where the "wobble" becomes pronounced and in this region of high efficiency the arc current is of the order of about 0.5 ampere per inch of arc length whereas in the region between the points A and C a closer approximation is the relation between the arc length and the arc cross section which is about 0.025 inch diameter of arc to each inch of arc length.

In the particular lamp shown in Fig. 1 the enclosing envelope *l* was approximately 19 inches in length and approximately  $2\frac{1}{4}$  inches in internal diameter. The arc length "L" was approximately  $17\frac{1}{2}$  inches and the lamp was arranged to be operated at approximately 2000 watts power input from a suitable source. When the lamp was operating at maximum lu-

minous efficiency the arc width "D" was approximately 0.8 inch and the arc current was approximately 8.5 amperes, the vapor density of the mercury vapor filling being approximately 0.7 atmosphere at this point of maximum luminous efficiency. It will be understood of course that the invention is not limited to any particular size of lamp or to any particular power input as long as the ratios between arc length and arc current or between arc length and arc cross section are substantially those described above. Accordingly, various changes and modifications may be made herein without departing from the spirit and scope of the invention.

15 What is claimed is:

1. In combination a high pressure vapor arc lamp comprising an enclosing envelope having a filling of mercury vapor and a small percent of an inert conductive gas, a pair of electrodes mounted at opposite ends of said envelope, a shield in back of each electrode to control the convection currents within the vapor, and means to apply

a voltage across the electrodes to strike an arc having a ratio of arc length in inches to arc cross section in square inches of the order of 1.0/0.0005.

2. The combination according to claim 1 in which the enclosing envelope is substantially cylindrical and the electrodes are provided with pointed opposing portions between which the arc column is localized, the said pointed portions being located on the central longitudinal axis of the envelope.

3. In combination, a high pressure vapor arc lamp comprising an enclosing envelope having a filling of mercury vapor and a small percent of an inert conductive gas, a pair of electrodes mounted at opposite ends of said envelope, a shield in back of at least one electrode to control the convection currents within the vapor, and means to apply a voltage across the electrodes to strike an arc having a current whose numerical value in amperes is greater than twice the numerical value of the arc length in inches.

LAURENCE BURNS.

Feb. 1, 1938.

E. GRETENER

2,107,148

REFLECTOR ARC LAMP FOR THE PROJECTION OF COLORED PICTURES

Filed Feb. 6, 1936

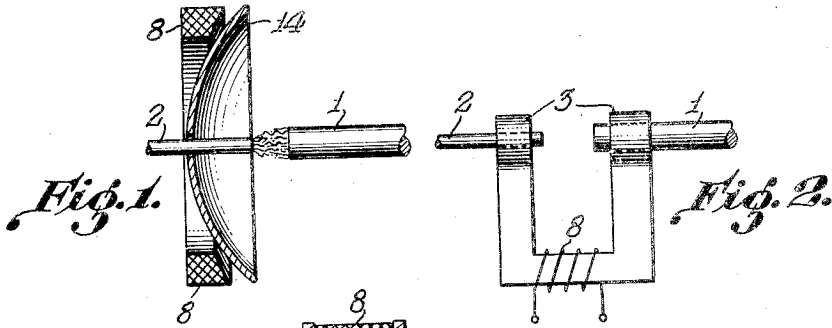


Fig. 1.

Fig. 2.

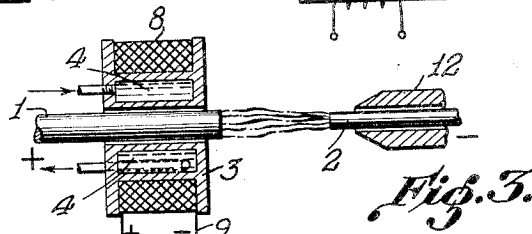


Fig. 3.

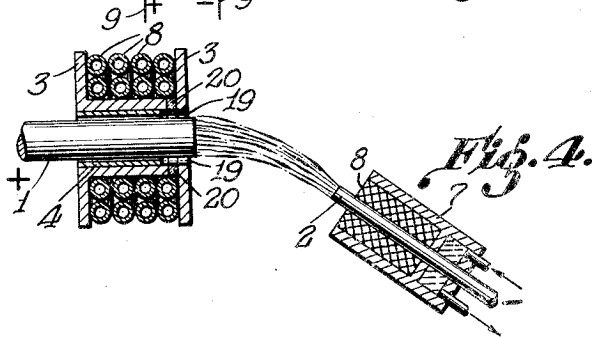


Fig. 4.

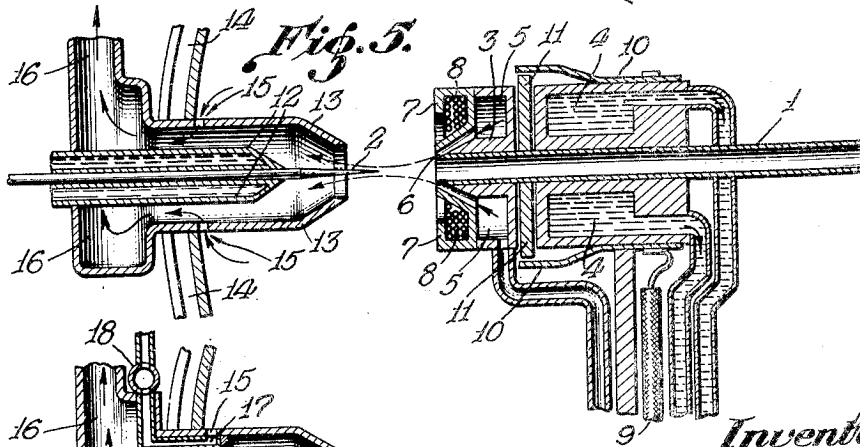


Fig. 5.

Fig. 6.

Inventor:  
Edgar Gretener  
by Eiffert, Scull & Burgess  
Attorneys.

# UNITED STATES PATENT OFFICE

2,107,148

## REFLECTOR ARC LAMP FOR THE PROJECTION OF COLORED PICTURES

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1 Claim. (Cl. 176—118)

My invention relates to an arc lamp, and more particularly to a reflector arc lamp for the projection of colored pictures that may be advantageously applied also to projectors and similar devices. To attain a true reproduction of colored films, particularly of reticulated films, the light source for the projection, as a rule, calls for a particularly high degree of brightness and uniformity of the distribution of the light emitted. To attain the necessary uniform and stable illumination of the film gate when projecting the crater of the positive electrode onto the film gate the brightness in the crater of the electrode must be as uniform as possible.

This may be accomplished according to the invention by the simultaneous use of a symmetrical magnetic field with respect to the axis of the discharge and of a cooled sleeve which surrounds the positive electrode close up to the burning tip.

The disadvantage of the lamps hitherto employed consists above all in the unstable burning off of the electrodes which, as a rule, results from the wandering of the crater. In order to attain nevertheless a uniform illumination of the film gate to a certain extent it has hitherto been necessary to use electrodes having a particularly large cross-section, which is particularly disadvantageous from an economical point of view, since the consumption of energy is considerably increased thereby. In this case only a small portion of the electrode was luminous, whereas the other portions of the tip of the electrode were projected on the portion surrounding the film gate, so that the latter was heated unnecessarily.

According to the invention the above-mentioned drawbacks are removed and a source of light as homogeneous and stable as possible is obtained by the use of magnetical longitudinal fields in guiding the arc and by limiting the luminous surface with the aid of a tightly disposed sleeve. In this manner by the concentration of the arc discharge a stable arc of great length is attained as well as a uniform consumption of the electrodes. Owing to the lengthening of the arc it is also possible to arrange both electrodes in one axis without thereby causing any appreciable shadowing. In this case the magnetic field prevents in connection with the sleeve any lateral burning off of the carbon. By intensely cooling the sleeve it is also possible to produce this effect even at the tip so that the carbons burn off in a uniform manner. The current can only leave the electrode at the end

face so that also only the latter emits the light. Besides effecting a saving in energy the further advantage is obtained in that the development of heat is prevented. The heat radiating from the luminous surface is, moreover, absorbed to a great extent by the cooled sleeves. Furthermore, the ends of the electrodes burn off in such a manner that the burning surface presents only a very shallow crater and a rounding off of the electrodes is also eliminated, even if the carbon pencils are particularly overloaded.

The guide of the arc is preferably effected by the use of a current-carrying coil. The coil is arranged in such a manner that the axis of the magnetic field coincides substantially with the direction of the axis of the arc discharge.

The coil may, for instance, be arranged behind the mirror of a reflector arc lamp, in the optical axis of which are arranged both electrodes. It is is, however, advantageous to place the coil as close as possible to the discharge. In this manner the same strength of field with a considerably smaller number of ampere turns may be obtained than has hitherto been possible. In this case the coil may be either so arranged as to concentrically surround an electrode or it may be divided into various parts which are distributed over both electrodes or these parts may be so arranged that the resulting field coincides substantially with the axis of the discharge.

By such an arrangement it is possible to produce the magnetic field directly at the point at which it is needed. The magnetic field may easily be so distorted by the considerable iron masses of the lamp or casing that it serves its purpose only insufficiently or not at all, insofar as the stabilizing action of the field depends largely upon its adjustment. On the other hand, it may be of advantage to diminish the influence of the other iron masses or electric fields or to strengthen the magnetic flux or to develop the magnetic field by a particular shape of the sleeve; for instance, by only a partly closed sleeve in such a manner that the magnetic field assumes a particularly suitable form.

The coil is so intensely heated by the heat of the arc and by the current flowing therein that it is of advantage to provide also a cooling for the coil, preferably by water. In this case the coil may be directly cooled, for instance, by water which flows through the coil or the cooling may be effected indirectly by a good heat contact with cooled metallic masses; for instance, with the sleeve of the anode. The electrode is in direct contact with a sleeve, over which a coil is tightly

wound or the electrode is spaced therefrom only by a narrow gap.

The coil arranged in the neighborhood of the electrode is particularly suitable to be designed as series coil; the lamp current is caused to flow directly through a relatively small number of turns having a thick cross-section and produces in this manner the magnetic field which is employed for the stabilization without the necessity of any special auxiliary means. Particular leads are also dispensed with which cause an unnecessary loss of light, since they lie in the path of the rays. The coil may, of course, also be traversed only by a portion of the lamp current either to supply still another coil with the residual current or to influence thereby the magnitude and the direction of the magnetic field. It may also be of advantage to utilize the voltage, by which the lamp is operated for maintaining the coil current (shunt) or for combining this method of operation with the series system in order to attain the desired relationship between the field and the operating current and arc voltage.

It has further been found that the symmetrical magnetic field is particularly advantageous if it possesses radially directed intense components, especially if the arc lamp is used for the projection of moving pictures. While the magnetic field in the axis of the discharge runs in parallel relation to the discharge the strength of the magnetic field outside of this axis has a direction which is inclined with respect to the discharge. The action of this particular formation of the field will be understood by the following test:

On examining the luminous surface of the positive electrode stroboscopically, bright and dark portions revolving on the luminous surface will be perceived. Since in the case of the projection of moving pictures a stroboscopic effect also occurs by the use of the rotating diaphragm the above-mentioned inhomogeneity may interfere with the illumination to a considerable extent. The period of rotation of this inhomogeneity with respect to the frequency of pictures per sec. must be fixed, so that the bright surface appears homogeneous. This may be accomplished according to the invention by intense radial components of the magnetic field. The inhomogeneity should revolve, for instance, in the case of the normal frequency of 24 pictures per sec., at least once, preferably several times within 1/48 sec. When inserting dark intervals for reducing the flickering to a minimum, the speed of rotation must be changed accordingly. Such a homogenization is not only of importance for the projection of moving pictures but it may, as a rule, be employed for a variety of purposes.

The uniformity of the luminous surface depends upon the intensity of the radial field components, besides upon the arc length and current intensity and when forming this field care should be, therefore, taken to have a sufficiently intense radial component along every point of the discharge path, while maintaining the symmetrical distribution within strict limits. The magnetic field may, for instance, be produced by a coil concentrically disposed with respect to an electrode, the coil being preferably arranged between two cylinders of magnetic metal. In this manner a longitudinal field is formed in the axis of the discharge, whereas the lines of force formed away from the axis of the discharge are bent towards the outer jacket and cause the formation of the radial components. This radial

field is particularly strong, if the coil is magnetically closed at its back side so as to form a double-walled pot surrounding the electrode. A particularly suitable magnetic field is also created if both the positive and the negative electrodes are surrounded by a current-carrying coil, the polarity of the coils being so chosen that the poles of the same sign are opposite to one another.

The invention is illustrated in the accompanying drawing.

Fig. 1 is a diagrammatic section through an arc lamp, showing the arrangement of a stabilizing coil.

Fig. 2 is a diagram showing the use of magnetic materials for the production of the magnetic field.

Fig. 3 is a view similar to Fig. 1, illustrating the assembly of the sleeve and coil to a unit.

Fig. 4 is a view similar to Fig. 1, showing the coil arrangement in which the electrodes are inclined with respect to each other.

Fig. 5 is a view similar to Fig. 1, illustrating a particular suitable type of an arc lamp according to the invention.

Fig. 6 is a section through one electrode, showing a suitable form for reflector arc lamps.

In Fig. 1, 1 and 2 denote the two carbon electrodes between which the arc is formed. Both electrodes lie in the optical axis of the mirror 14 which reflects the light of the arc. The stabilizing coil 8 is arranged concentrically with respect to the electrodes behind the mirror so that the magnetic field is also symmetrical.

Fig. 2 shows an embodiment in which both carbon electrodes 1 and 2 are surrounded by a sleeve 3 of magnetic material. The field is produced by the coil 8 and extends between the electrodes in the direction of the arc.

Fig. 3 shows also an arc lamp, the positive electrode of which is surrounded by a coil 8, in the core 4 of which water circulates. The winding 8 is arranged directly on the water-cooled sleeve 3. The negative electrode 2 is not cooled, but it has an iron jacket 12 of particular form which concentrates the magnetic field on the tips of the electrode 2 and causes the formation of the radial components. 9 are the leads for the coil current.

Fig. 4 shows a further embodiment in which the positive electrode 1 is surrounded by a coil 8 consisting of tubes in which water is circulated. Through these tubes the lamp current is supplied. The support 3 of the coil is designed as a sleeve tightly disposed around the electrode 1, and protects the electrode from consumption and centers the same. The portion in direct contact with the carbon consists of iron in order to crowd the field together and extends so far along the electrode 1 as to leave a narrow gap 13 at the front end between the sleeve 3 and the electrode 1, the gap causing a radial stray field and at the same time preventing too intense a cooling of the luminous surface. In order to prevent the discharge from taking place on the sleeve, the front part thereof is insulated by an intermediate layer 20. The negative electrode 2 is also provided with a coil 8 surrounded by an indirectly cooled iron jacket 7 which is open at the front end thereof. In such an arrangement, in which the electrodes are inclined with respect to each other it is essential that the field resulting from the two coils be exactly adapted to the path of current in the arc and that all outer interferences be prevented.

5 An arc lamp, in which the invention is embodied in a particularly suitable form is shown in Fig. 5. The positive electrode 1 is surrounded by a sleeve 3 preferably made of steel. The sleeve is cooled by water and protects the jacket surface of the electrode. The sleeve is provided with the coil 8 which is surrounded by a pot 7 consisting of iron. Owing to the action of the coil and the particular shape of the pot a magnetic stray field of high intensity is formed which is symmetrical with respect to the axis of the electrode 1 and which is radially directed to a great extent particularly in the immediate neighborhood of the luminous end face of the positive electrode. Further in Fig. 5 a device is shown which is of particular value in conjunction with cored carbons and which permits of a stabilization of the arc beyond the magnetic action. That is to say, a strong converging current of air is blown into the arc from the air chamber 5 through the nozzle 6 and strikes the negative electrode 2. The current of air passes then through the casing 13 and the chamber 16 and effects a complete combustion of the rare earths present in the cored carbons as well as an entrainment of the residues of combustion. The air on entering the branch 13 produces a depression which causes the air to be drawn in from the surrounding air space through the openings 15 or through the front opening of the branch. This current of air entrains all the particles ejected from the electrode thus preventing them from depositing on the hollow mirror 14.

However, it is also possible as shown in Fig. 6 to draw in air by a particular pump 18 through the openings 15 and the suction conduit 17 in order to create a strong current of air, and thus to prevent with certainty the glowing particles from reaching the mirror.

The supply of the current to the positive electrode is provided by the cable 9, the springs 10 and the brushes 11 which are pressed against the metal surface of the electrode. It is essential that the current be supplied as close as possible to the tip of the electrode in order to reduce the heat developed in the carbon to a minimum, since otherwise an evaporation of the core material and, under some circumstances, an ejection of material from the jacket may occur.

The cooling of the sleeve is effected by water which flows through the chamber 4. Also the negative electrode 2 may be surrounded by a water-cooled sleeve 12 so as to prevent a premature burning of the electrode.

I claim as my invention:

In an arc lamp comprising positive and negative electrodes, a magnetic coil surrounding the positive one of said electrodes and extending closely adjacent the point thereof, a sleeve closely surrounding said positive electrode adjacent said point, means rapidly cooling said sleeve, and a metallic pot substantially enclosing said coil and having one wall disposed between the coil and the electrode and another wall on the side of the coil away from the electrode.

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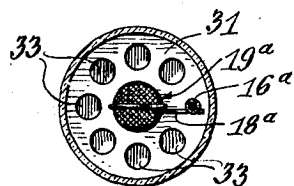
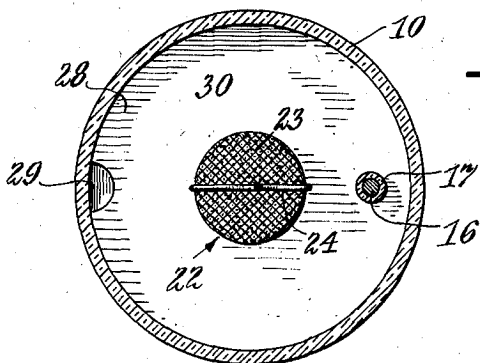
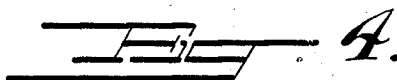
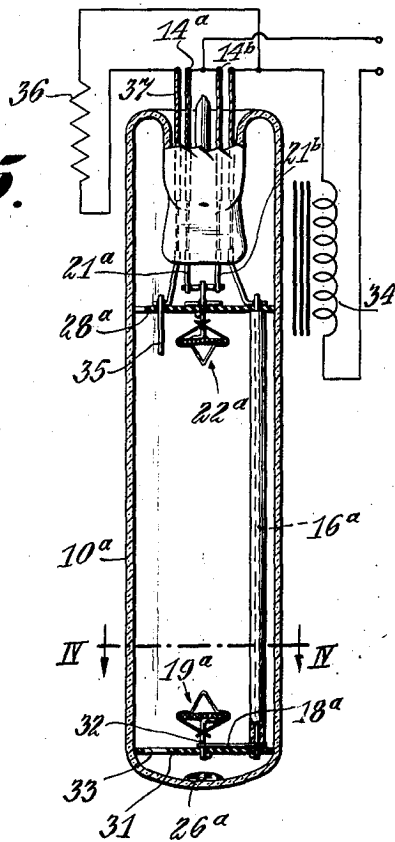
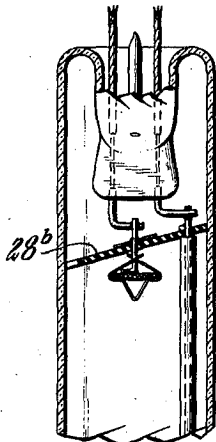
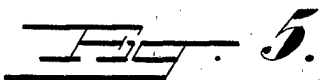
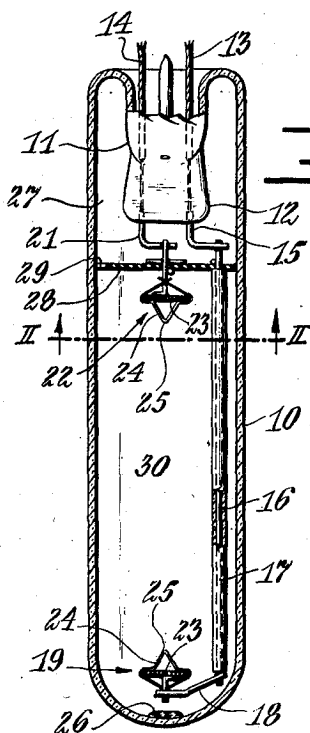
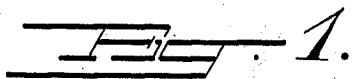
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J. W. MARDEN ET AL

2,129,357

MERCURY VAPOR LAMP

Filed Oct. 8, 1936



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## UNITED STATES PATENT OFFICE

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## MERCURY VAPOR LAMP

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Application October 8, 1936, Serial No. 104,596

12 Claims. (Cl. 176—122)

This invention relates to a discharge lamp and more particularly to a high intensity lamp employing mercury or other metallic vapor.

In our copending application Serial No. 49,448, filed November 13, 1935, a lamp is shown and described in which the importance of the relation between the bulb length, bulb diameter, pressure, and other factors are pointed out. In lamps made in accordance with the teachings of the above mentioned copending application, although satisfactory and of importance in the lamp art, certain manufacturing problems arise particularly in controlling the quantity of mercury which, in such lamps, must be so limited in amount that during the operation of the lamp the entire deposit of mercury is vaporized.

In accordance with the present invention a lamp is produced in which an excess amount of mercury is employed; that is, the amount of liquid mercury introduced into the bulb is greater than is necessary to support the desired arc discharge. A supply source of mercury is provided and after a sufficient amount of mercury from the source is vaporized to produce the discharge, it passes to cooler portions of the bulb and condenses to liquid form. The bulb and its operating elements are so constructed and arranged that the condensed or liquid mercury flows back to the supply source. Thus a continuous replenishment of the source is effected, resulting in a continuous operation of the lamp in a current of mercury vapor.

It is an object of the present invention to provide a mercury vapor lamp of simple construction and efficient operation.

Another object of the invention is to provide a high intensity mercury vapor lamp in which a continuous supply of vaporized mercury is produced.

A further object of the invention is to provide a mercury vapor lamp containing an amount of liquid mercury which is in excess of that needed in vapor form, and to arrange and construct the lamp elements to so control the vaporized mercury that an amount sufficient for the operation of the lamp is utilized and excess vapor is condensed and returned for revaporization.

A still further object of the invention is the provision of an arc lamp containing mercury, in excess of that needed to maintain the discharge, and having a chamber or portion projecting above the arc for condensing mercury, when its vapor pressure exceeds that desired, and allowing it to return by gravity for redistillation, so that the

arc operates in a stream of upwardly ascending mercury vapor.

Other objects and advantages of the invention will be more clearly understood by reference to the following description together with the accompanying drawing in which:

Fig. 1 is a longitudinal sectional view, with parts in elevation, of one form of lamp constructed in accordance with the present invention, and having a partition at one end of the bulb to provide a condensation chamber;

Fig. 2 is an enlarged cross-sectional view on the line II—II of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a longitudinal sectional view, with parts in elevation, of a lamp constructed along the lines of that shown in Fig. 1, but in which a compartment is provided at each end of the bulb, a wiring diagram, disclosing one way of using the lamp, being illustrated;

Fig. 4 is a transverse sectional view on the line IV—IV of Fig. 3, looking in the direction of the arrows; and

Fig. 5 is a fragmentary view, corresponding to Figs. 1 and 3, but showing a partition in diagonal relation to the bulb wall.

Although the present invention may be employed in connection with various types of discharge lamps, a preferred embodiment, illustrated in Figs. 1 and 2, is a lamp with a bulb of hard glass, quartz, pyrex, or the like, having a reentrant tube terminating in a press through which lead wires or conductors are sealed. Lead wire connects with a conductive support to which is connected one end of a rigid conductive support rod. This rod is encased in a sleeve of glass, or other suitable insulating material, and its other end is secured to an extension member. The conducting member extends transversely of the bulb and carries an electrode, desirably located on the longitudinal axis of said bulb. The lead wire is connected to a rigid support member which also extends transversely of the bulb and carries an electrode, desirably aligned with the electrode on the bulb axis.

The electrodes are preferably of similar construction. Each may be considered as a dual or compound electrode consisting of an electron emitting plate or disk and a refractory conducting member. The disk may be formed of nickel wire mesh, the interstices of which are filled or impregnated with electron emission material such as barium oxide, strontium oxide, another alkali earth, or mixtures thereof. When

the supporting body or mesh has been suitably impregnated or filled with the electron emission material, outer portions of the latter are desirably removed so that the outer face of the mesh or enclosing material is exposed.

Each disk 23 is desirably carried by the corresponding conductor extending from the members 18 or 21 and associated therewith is the bridge piece 24, preferably formed of refractory metal such as tungsten, which becomes effectively electron emissive at high temperatures, desirably having its ends welded to the corresponding conductor and extending across the inner or opposite surface of the disk 23, with its intermediate portion 25 bent toward the other electrode so as to be spaced from the surface of the associated disk 23. In this way electrodes are provided which have activated portions adapted to emit electrons at relatively low temperatures, and other portions which become electron emitting at higher temperatures and carry the main portion of the arc or discharge when the lamp is in operation, thereby protecting the electron emitting disks from deterioration, all as more fully described and claimed in our copending application Serial No. 733,168, filed June 30, 1934.

Within the bulb is a quantity of mercury 26. A small quantity of a rare gas, such as neon, may be introduced into the bulb to produce an initial discharge which heats the body of mercury, producing vapor which supports a relatively heavy flow of current between the electrodes. As the temperature of the device rises, more mercury is vaporized and, by reason of the voltage between the electrodes, an intensive glow occurs in the form of an ionized column of mercury.

During operation, the mercury is vaporized and travels upward to all parts of the bulb. In accordance with the present invention, a condensation chamber is provided at 27 so that any mercury vapor reaching it is condensed and flows back to the initial supply. The chamber 27 of the present embodiment includes the wall of the bulb and the wall of the partition 28, desirably formed of mica or the like, and surrounds the reentrant tube 11 which serves as a heat absorbing element.

One or more apertures or notches 29, provided in the partition 28, afford communication between the cooling chamber 27 and the discharge chamber of the lamp, which latter chamber is designated by the reference numeral 30. The discharge between the electrodes 19 and 22 takes the form of an arc stream of high intensity extending in a substantially straight line between the electrodes. The vapor supply for the arc emanates from the mercury body 26 and ordinarily the entire quantity of mercury would become vaporized.

As the lamp continues to operate, the mercury supply is drawn upon and used, but some of the vapor surrounding the column finds its way to chamber 27 and, by reason of the cooling effect of the walls of the chamber, is condensed and flows down the wall of the bulb back to the source of supply. Thus the mercury supply source is replenished as the lamp operates, making it possible to continuously operate the lamp at maximum efficiency in a rising stream of mercury vapor of the desired pressure.

Referring now to the embodiment of our invention illustrated in Figs. 3 and 4, there is shown a lamp similar to that of Figs. 1 and 2, except that the construction is somewhat more rigid in that means is provided for positively

centering the lower electrode 19<sup>a</sup>. In order to accomplish this purpose, a second partition 31, similar to the partition 28<sup>a</sup> in the upper part of the bulb 10<sup>a</sup>, is provided, said second partition, however, being apertured to not only receive and center the free end of the conductor 32 from the electrode 19<sup>a</sup>, but also apertured, as indicated at 33, to allow free transmission of heat to the mercury 26<sup>a</sup> therebeneath.

In order to position the partition as close as possible to the end of the bulb and mercury contained therein, the connection between the support rod 16<sup>a</sup> and the conductor 32 is made by a conductor or extension member 18<sup>a</sup> disposed above rather than below said partition. In this way, the lower electrode 19<sup>a</sup> is positively centered in the bulb 10<sup>a</sup> independent of the rigidity of the support rod 16<sup>a</sup>.

It is, of course, desired to use a lamp such as described in the present application either with a ballast impedance, such as indicated at 34 in Fig. 3, or with a transformer which will automatically limit the current to a certain figure. If the pressure available is not more than 200 volts, as say between 100 and 200, it is desirable to use a starting tip, as designated by the reference character 35 in Fig. 3, disposed adjacent the electrode 22<sup>a</sup> and connected to the lead to the other electrode through a high resistance 36, as by means of a lead-in wire 37.

In the embodiment of Figs. 3 and 4, the electrode 22<sup>a</sup> is connected through two leading-in conductors 14<sup>a</sup> and 14<sup>b</sup> terminating in rigid support members 21<sup>a</sup> and 21<sup>b</sup>, although the construction is merely alternative as providing a slightly more rigid structure and adapting the tube for a customary four-prong base.

Referring now to the embodiment of our invention illustrated in Fig. 5, a construction is disclosed which may be identical with either that of Fig. 1, or that of Fig. 3, except that the partition 28<sup>b</sup> adjacent the press is inclined with respect to the longitudinal axis of the bulb to more readily drain off the condensed mercury.

A lamp constructed in accordance with the present invention may include a bulb of five and a quarter inches in length and one and a quarter inches in diameter. One to two cubic centimeters of mercury is desirably employed in each bulb. The device, with argon filling at a pressure of from 10 to 20 millimeters, may be operated at sixty volts alternating current to produce an arc stream of high intensity.

A lamp with the dimensions above enumerated may be operated at 200 watts. Some device is employed, such as a suitable transformer or choke coil, to cause the potential drop in the lamp when operating under normal conditions, to be 60 volts with a current of 3.3 amperes. In other words, for example, on 220 volts an iron core impedance should be employed of a size sufficient to limit the current delivered so that the lamp gets 200 watts during operation. Larger and smaller lamps can be made in proportion as desired.

Although preferred embodiments of our invention have been illustrated, it will be understood that modifications may be made within the spirit and scope of the appended claims.

We claim:—

1. A mercury vapor discharge device comprising a bulb, having a press, leading-in conductors extending through said press, a pair of electrodes activated to emit electrons at relatively low temperatures, disposed one adjacent each end of said bulb, one of said conductors being connected to

the electrode adjacent thereto and the other extending to said other electrode, a pool of mercury in said bulb heated by the discharge from said electrodes, to provide vapor for supporting said discharge, and a chamber around said press and above said discharge to condense surplus vapor and return it to said pool.

2. A metallic vapor discharge device comprising a tubular bulb, electrodes in said bulb, a source of metallic vapor supply in said bulb to provide a conductive vapor to produce an arc discharge between said electrodes, a mere partition separating one end portion of said bulb from the remainder to provide a cooling chamber to receive and condense metallic vapor formed in said bulb in excess of that required for said arc discharge, said partition having an aperture for the flow of said condensed vapor back to the source of supply.

3. A mercury discharge device comprising a tubular bulb, electrodes in said bulb, a source of supply for mercury vapor in said bulb to provide means to conduct an arc discharge between said electrodes, a cooling chamber defined by a mere partition separating one end portion of said bulb from the remainder to receive and condense mercury vapor formed in said bulb in excess of that required for said arc discharge, and means for returning said condensed mercury to said source of supply.

4. A mercury vapor discharge device comprising a bulb, electrodes disposed one adjacent each end of said bulb, a pool of mercury in said bulb heated by the discharge from said electrodes to provide vapor for supporting said discharge, and a mere partition disposed above said discharge to divide off a portion of the bulb to provide a cooling chamber for the condensation of surplus vapor.

5. A mercury vapor discharge device comprising a bulb, electrodes disposed one adjacent each end of said bulb, each electrode comprising a portion adapted to emit electrons at low temperature and another portion extending across the inner surface thereof and with an intermediate portion bent away so as to be spaced toward the other electrode for taking the main discharge when the device is in operation and protecting the electron emitting material, a pool of mercury in said bulb heated by the discharge from said electrodes to provide vapor for supporting said discharge, and a chamber above said discharge to condense surplus vapor and return it to said pool.

6. A metallic vapor discharge device comprising a tubular bulb having a press, leading-in conductors extending through said press, electrodes disposed one adjacent each end of said bulb, one of said leading-in conductors being connected to the electrode adjacent thereto and the other traversing substantially the length of the bulb and connected to the other electrode, an insulating sleeve protecting the tube-traversing conductor between said electrodes, a pool of mercury in said bulb heated by the discharge from said electrodes, and a partition intersected by both conductors and serving to divide the portion adjacent said press from the remainder of said bulb to provide a cooling chamber for condensing surplus mercury vapor and returning it to said pool of mercury during the operation of the device.

7. A metallic vapor discharge device comprising a tubular bulb having a press, leading-in conductors extending through said press, electrodes disposed one adjacent each end of said bulb, one of said leading-in conductors being connected to the electrode adjacent thereto and the other trav-

ersing substantially the length of the bulb and connected to the other electrode, an insulating sleeve protecting the tube-traversing conductor between said electrodes, a pool of mercury in said bulb heated by the discharge from said electrodes, a partition intersected by both conductors and serving to divide the portion adjacent said press from the remainder of said bulb to provide a cooling chamber for condensing surplus mercury vapor and returning it to said pool of mercury during the operation of the device, and another partition disposed adjacent the other end of said bulb for centering the adjacent electrode.

8. A metallic vapor discharge device comprising a tubular bulb having a press, leading-in conductors extending through said press, electrodes disposed one adjacent each end of said bulb, one of said leading-in conductors being connected to the electrode adjacent thereto and the other traversing substantially the length of the bulb and connected to the other electrode, an insulating sleeve protecting the tube-traversing conductor between said electrodes, a pool of mercury in said bulb heated by the discharge from said electrodes, and a partition intersected by both conductors and serving to divide the portion adjacent said press from the remainder of said bulb to provide a cooling chamber for condensing surplus mercury vapor and returning it to said pool of mercury during the operation of the device, said partition being tilted with respect to the bulb axis to more readily drain mercury therefrom.

9. A vapor discharge device comprising an envelope, electrodes disposed therein, one adjacent each end of said envelope, each electrode comprising a portion activated to emit electrons at low temperatures and another portion extending across the inner surface thereof and with an intermediate portion bent away so as to be spaced toward the other electrode for taking the main discharge and protecting the activated material, said envelope containing a rare gas at a pressure of from 10 to 20 m. m. of mercury admixed with mercury vapor, a surplus of liquid mercury heated by the discharge between said electrodes, and a chamber above said discharge for condensing surplus vapor.

10. A vapor discharge device comprising an envelope, leading-in conductors, electrodes disposed one adjacent each end of said envelope, one of said conductors being connected to the electrode adjacent thereto and the other traversing substantially the entire length of the envelope and connected to the other electrode, insulating means protecting the envelope-traversing conductor between said electrodes, mercury in said envelope heated by the discharge from said electrodes, a partition intersected by both conductors and serving to divide the portion adjacent one electrode from the remainder of the envelope, to provide a cooling chamber for condensing surplus mercury vapor, and another partition disposed adjacent the other electrode for centering the same.

11. A vapor discharge device comprising an envelope, leading-in conductors, electrodes disposed one adjacent each end of said envelope, one of said leading-in conductors being connected to the electrode adjacent thereto and the other traversing substantially the length of the envelope and connected to the other electrode, insulating means protecting the envelope-traversing conductor between said electrodes, liquid mercury in said envelope heated by the discharge between said electrodes, and a partition intersected by said conductors and serving to divide a portion adjacent

- one of the conductors from the remainder of said envelope, to provide a cooling chamber for condensing surplus vapor, said partition being diagonally disposed with respect to the axis of the device.
- 5 12. A discharge device comprising an envelope having a press, leading-in conductors extending through said press, electrodes disposed one adjacent each end of said envelope, one of said leading-in conductors being connected to the electrode adjacent thereto and the other traversing enough of said envelope to connect with said other electrode, insulating means protecting said last mentioned conductor between said electrodes, a quantity of mercury in said envelope heated by the discharge in said device, and a portion of said envelope forming a cooling chamber around said press for condensing surplus mercury vapor during operation.
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July 25, 1939.

E. GERMER  
DISCHARGE DEVICE  
Filed Jan. 25, 1936

2,166,951

Fig. 1.

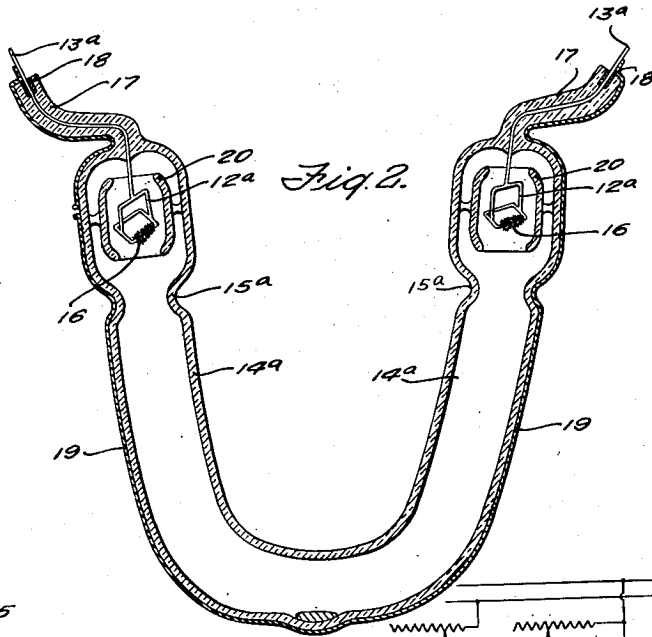
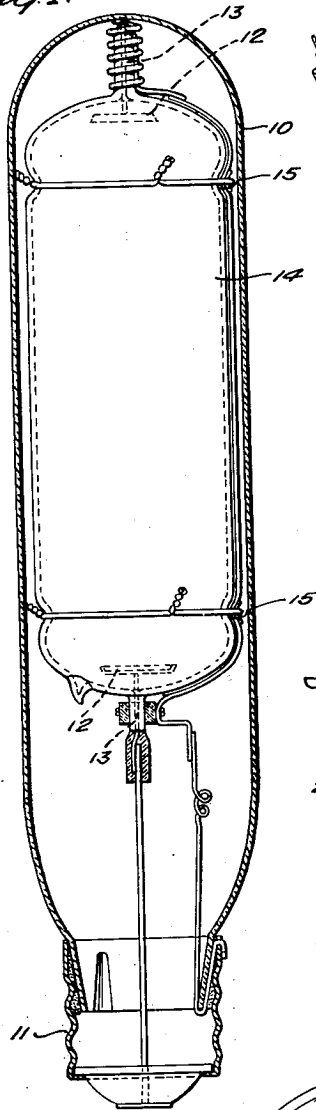


Fig. 2.

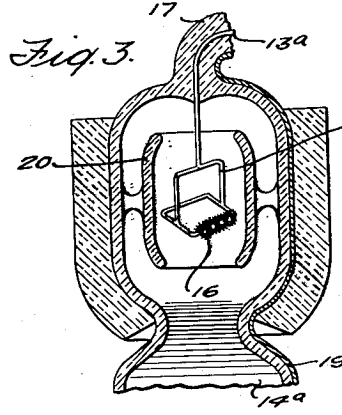


Fig. 3.

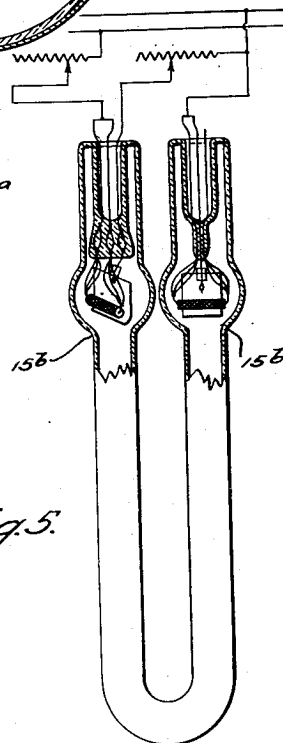
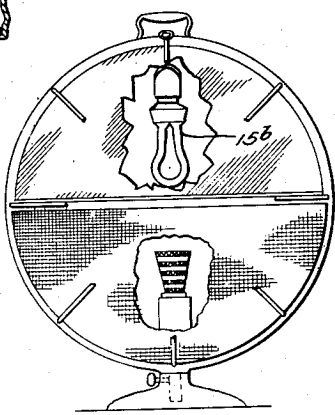


Fig. 5.

Fig. 4.



INVENTOR  
EDMUND GERMER  
By *Harold S. ...*  
ATTORNEYS

# UNITED STATES PATENT OFFICE

2,166,951

## DISCHARGE DEVICE

Edmund Germer, Berlin, Germany, assignor of  
eighty-seven and one-half per cent to Ulrich  
W. Doering and Hans Joachim Spanner, both  
of Berlin, Germany

Application January 25, 1936, Serial No. 60,774  
In Germany July 1, 1929

5 Claims. (Cl. 176—122)

This invention relates to gaseous electrical discharge devices and more particularly to such devices in which a metal vapor constitutes at least a part of the gaseous atmosphere through which the discharge occurs.

The present application is a continuation in part of my prior applications: Serial No. 500,346, filed December 5, 1930, and Serial Nos. 397,428 and 397,429, filed October 4, 1929. In these applications I have described and claimed devices in which a discharge occurs between fixed electrodes through an atmosphere of a gas or vapor. The electrodes as described in my prior application are specially activated with the result that there is only a very small electrode drop and consequently the electrode operates at relatively low temperatures except for the actual arcing point, and the ends of the tube behind the electrode are therefore the coolest part of the tube at which condensation is most likely to occur.

Furthermore, as set forth in my prior application, the electrodes in such a tube are advantageously made of nickel, but even at the relatively low temperatures of operation nickel tends to evaporate very slowly from the electrode to the wall of the enclosing envelope, where the nickel deposit produces a darkening and a consequent loss of luminous efficiency of the tube.

According to the invention which forms the subject of the present application, condensation of vapors on the ends of the enclosing envelope and darkening of the principal luminous portion of the envelope are avoided by so constructing and/or mounting the envelope that currents in the gas or vapor are set up within the electrode chambers near the path of the discharge from the electrode. These currents at once tend to sweep any evaporated or sputtered electrode material away from the luminous portion of the tube and back into the electrode chambers where it will condense on the cooler parts of the tube; and, in the case of vapor discharges, serve by heating of these cooler parts of the tube to prevent excessive condensation of the vapor filling.

In the drawing I have shown:

In Figure 1 a partial longitudinal sectional view of preferred embodiment of my invention;

In Figure 2 a longitudinal sectional view of another embodiment of my invention;

In Figure 3 a fragmentary sectional view of a tube having the lower part of its electrode chamber insulated;

In Figure 4 a view in elevation of a therapeutic ultra-violet radiator embodying my invention;

In Figure 5 a view on an enlarged scale partially in longitudinal section and partially in elevation of a gas discharge device such as that used in Figure 4.

In Figure 1, I have shown a lamp designed for standard installation and replacement for general illumination purposes. The gas discharge device proper is mounted within a protective jacket 10 on a standard connector base 11. Activated, self-heating, cold-emissive electrodes 12 are mounted on lead-in wires 13 at each end of the envelope 14 and the envelope is filled with a fixed gas at low pressure to start the discharge and a vaporizable material, which when vaporized becomes the principal agent of the luminous discharge.

The electrodes 12 are conductive bodies of refractory metal such as Ni, W, Ta, Pt, etc. and associated therewith a mass of at least partially reduced oxide of an emissive metal such as BaO with or without other more refractory oxides.

The filling gas is preferably one of the rare inert gases, and the vaporizable material, a metal e. g., Hg, Ti, Ga, alkali metals, etc.

This lamp is described more in detail in the copending application of Hans J. Spanner, Serial No. 744,206, filed September 15, 1934.

The lamp of Figure 1 is burned in vertical position and generally base up, thus giving in the upper end the special convection action herein after described.

When the lamp is thus operated in vertical position, the constrictions 15 in the wall of the envelope have a special function closely related to that of the vertical positioning already mentioned, namely to break up the space within the envelope into more or less separate convection zones. These constrictions turn the convection currents which pass down along the cooler walls inwardly toward the hot zone of the discharge where, becoming heated and entrained in upward currents, the gases or vapors are again turned upward. Only the coolest part of the gases, from which all electrode material will have been deposited on the electrode chamber or the constriction, will escape from the upper chamber into the principal luminous portion of the tube below. These cyclic currents over the electrodes tend to carry any material which is vaporized or sputtered from the electrodes directly to the wall of the electrode chamber, and there to deposit it on the relatively cool surfaces where it does not interfere with the major luminous radiation from the tube.

At the bottom of this lamp the action is less

efficient but the constriction still tends to serve the same purpose. In this case, the cooling on the wall of the envelope 14 above the constriction 15 produces a downward convection current toward the electrode end. Without the constriction these currents pass smoothly along the wall to the bottom of the envelope where they are caught in the upward draught due to the heating of the electrode and the discharge path, and then pass rapidly up into the center of the tube eventually to return to the vicinity of the wall and the downward convection current. At this return there will always be some tendency to deposit sputtered or evaporated electrode material. The constriction 15, however, intercepts this smooth flow of convection current and turns the downward current from the wall of the tube 14 inwardly toward the intensely heated arc path. Thus the cooler convection current from the wall of the tube tends to impinge upon the intensely hot current in the arc path just above the electrode with the consequence that they are suddenly expanded, thus creating a lateral blast toward the walls of the electrode chamber and further opposing the smooth downward flow of the cool convection current. As a consequence of this action more of the sputtered and evaporated electrode material will be deposited in the electrode end of the tube and left in the principal luminous portion between the constriction 15.

As will be evident to those skilled in the art, from what has already been said, these lamps are adapted for operation on either direct or alternating current, but with direct current it is preferable to operate the lamp with the cathode end uppermost.

In Figure 2, I have shown a modified embodiment of my invention in which both ends of the tube are positioned upwardly from the luminous portion of the tube so as to take fullest advantage of the action specifically described above in connection with the upper electrode chamber and constriction.

The construction and form of the electrodes 12a, the electrode mountings 16, the lead-in wires 13a, and the seals 17-18, and the wall strip 19, as well as the particular ingredients and proportions of the filling gases and vapors have been fully disclosed in my said prior application Serial No. 500,346 and need not be discussed in detail herein. It is sufficient to say that the tube 14a, its electrodes 12a, and other parts, are similar in principle and operation to the tube and electrodes etc. of Figure 1. They are constructed for high temperature operation and the electrodes 12a are activated electrodes.

The filling of the lamp includes a vaporizable metal, e. g., mercury, thallium, gallium, alkali metals, etc.

The wall of the envelope at the mouth of the electrode chambers is constricted as shown at 15a so that it projects inwardly close to the path of the arc or other discharge between the electrodes, and consequently the wall will become most highly heated at this constriction. In consequence any gases which flow down along the cooler wall of the electrode chamber will be deflected into a hot zone at this point, will be strongly heated and expanded and will be blown thereby back into the electrode chamber, as more fully described in connection with Figure 1.

The effect of the constriction is twofold; First, it serves mechanically to deflect the gases toward the hotter central zone, and secondly, it serves by its own higher temperature to heat

and therefore to expand the gases, and thus to blow them inwardly and back to the electrode chamber.

Although this action will occur most readily with the pole vessels in the upright position as shown in Figures 2 and 3, since, in this position the natural gravity currents resulting from the difference in density of the heated and cool gases and vapors will coincide with the currents due to their expansion and contraction respectively at the hot and cool temperatures, nevertheless, a similar action will occur to some extent regardless of the position of the electrode ends.

In some cases and especially with smaller lamps, e. g., up to 1.5 amps., current input, it is advisable to cover the lower parts of the electrode chambers with heat insulating materials such as asbestos, thus accentuating the effect of heating the gases at the mouth of the electrode chamber. This is illustrated, for example, in Figure 3.

In the example shown in Figure 2 this circulation within the electrode chambers is further facilitated by provision of special cylinders 20 surrounding the electrodes and spaced from the walls of the electrode chamber. These in effect are "stacks" heated at the bottom by the discharge, which create an up-draft, while the cooler walls of the electrode chambers tend to contract the hot gases issuing from the top of these "stacks" and thereby to produce a down-draft along these walls. This strong convection circulation results first in sweeping all sputtered electrode materials to the end of the tube behind the electrode and secondly in maintaining a constant heating of the walls of the electrode chamber which prevents objectionable condensation thereon.

In the example of Figures 4 and 5 that part of the tube for the arc path does not enlarge again beyond the constrictions 15b. This part of the tube being relatively small and close to the arc will all be highly heated and obviously its upper end at the constriction 15b will be at the highest temperature. In this case, therefore, as in the case illustrated in Figures 1 and 2, the constrictions 15b serve both mechanically and thermally to deflect the gases from their smooth down-flow along the tube wall.

Although I have shown in the accompanying drawing and described above one specific embodiment of my invention it should be understood, of course, that my invention is not limited to this particular form or construction and if the principles set forth above are born in mind those skilled in the art will have little difficulty in designing other forms and constructions by which the desired blast or convection current may be produced.

What I claim is:

1. An electrical discharge device of the type which comprises a container having electrode chambers and a principal luminous portion between the electrode chambers, electrodes at least one of which is a fixed solid electrode spaced from the walls of its electrode chamber, and a filling in said container adapted to carry the discharge comprising a vapor condensable at ordinary room temperatures, which device is characterized by means adapted to deflect away from the container wall gases which tend to pass from the electrode chamber into the principal luminous part of the container and to turn them back toward the electrode chamber and thus to confine mainly within the electrode chamber the



convection currents which pass over the electrode.

2. An electrical discharge device as defined in claim 1 in which the deflecting means is approximately beneath the solid electrode whereby the upward convection currents therefrom pass over the electrode and tend to sweep upward away from the principal luminous portion of the container any materials which are given off from the electrode.

3. An electrical device as defined in claim 1 in which the deflecting means comprises a constriction in the wall of the container adjacent the mouth of the electrode chamber.

4. An electrical discharge device as defined in claim 1 in which the deflecting means comprises thermal insulation about the container adjacent the mouth of the electrode chamber adapted to maintain during normal operation a higher wall temperature near said mouth than at adjacent parts of the container wall.

5. In a vapor arc lamp the combination of fixed electrodes at least one of which is an activated arc electrode, an envelope enclosing an elongated

space around and between said electrodes, and an arc carrying filling, comprising a material which is vaporized by heat from the discharge, and said envelope having pole vessels surrounding said electrodes, but sufficiently spaced therefrom so that their temperatures will be lower than the condensation temperature of any material vaporized from the electrode by the heat of the arc, whereby to concentrate in the pole vessels away from the principal luminous portion of the envelope any darkening from such vaporized material, and in which the pole vessel is a separate member carried by, but spaced over a major part of its area from the inner surface of the envelope whereby the wall of the pole vessel is insulated from the open atmosphere so as to be maintained at a temperature above that of the wall of the envelope around said pole vessel and any condensation of the metal vapor must occur on said envelope wall in preference to the wall of the pole vessel.

EDMUND GERMER.

June 30, 1964

J. A. BROWNING  
ELECTRIC ARC TORCH

3,139,509

Filed May 7, 1962

2 Sheets-Sheet 1

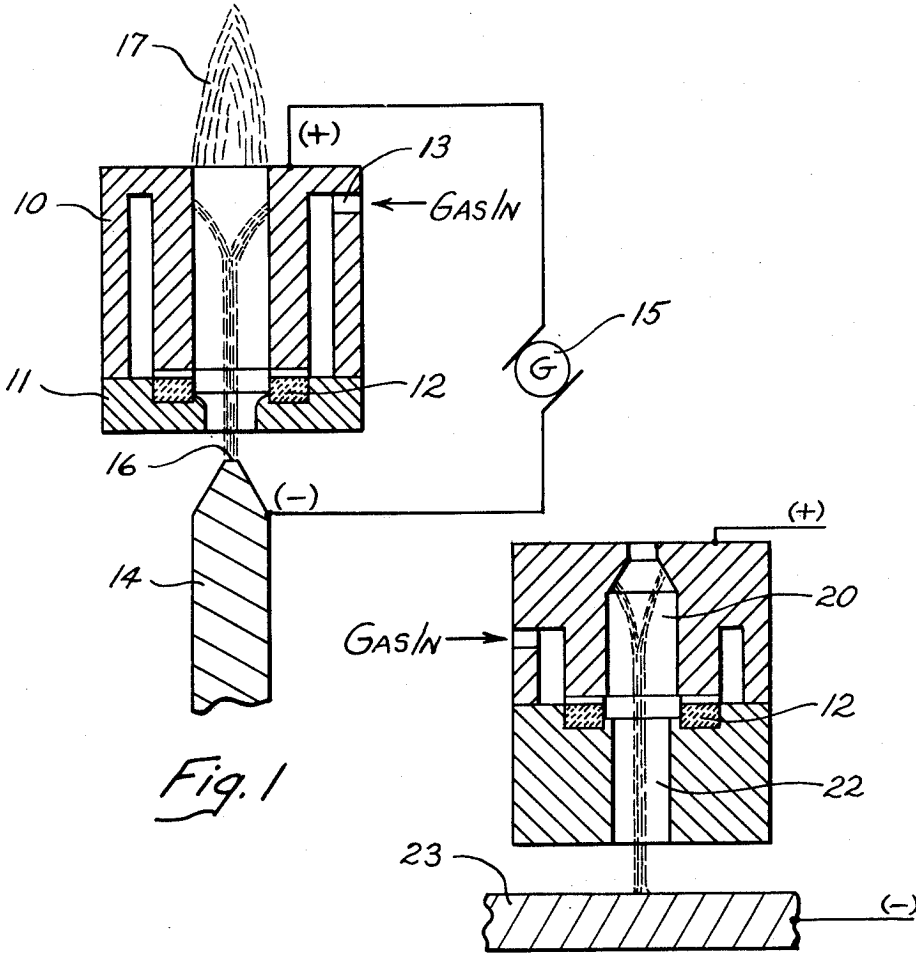


Fig. 1

Fig. 2

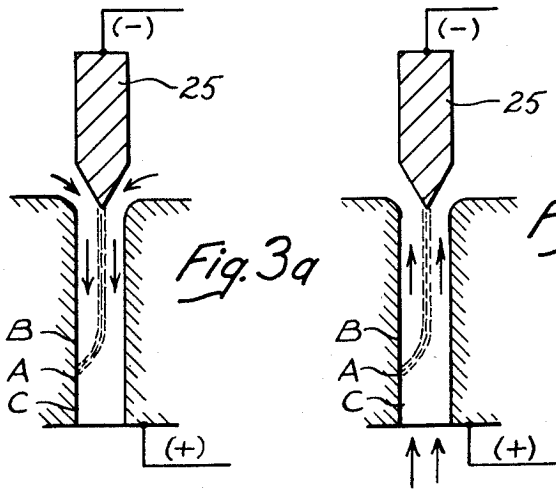


Fig. 3a

Fig. 3b

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June 30, 1964

J. A. BROWNING  
ELECTRIC ARC TORCH

3,139,509

Filed May 7, 1962

2 Sheets-Sheet 2

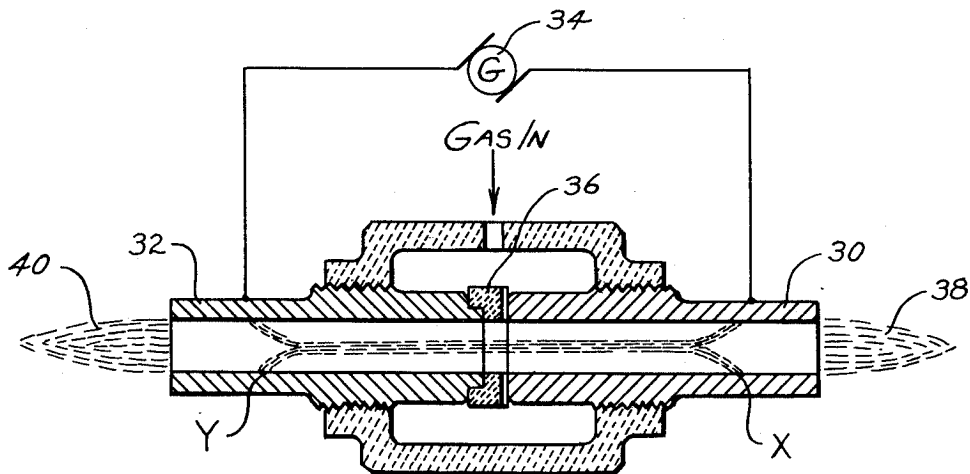


Fig. 4

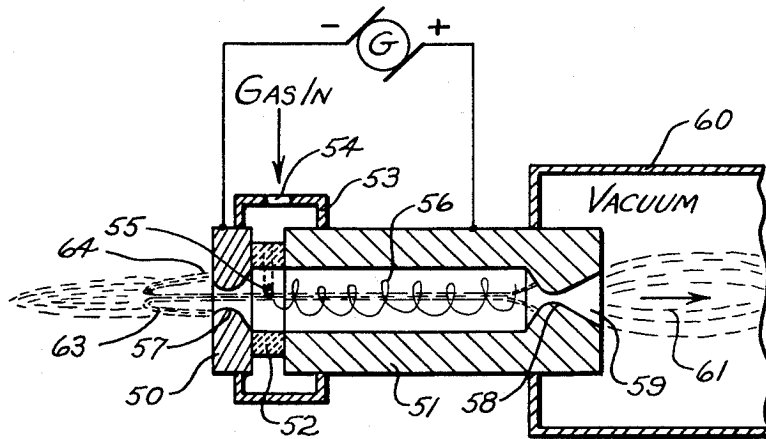


Fig. 5

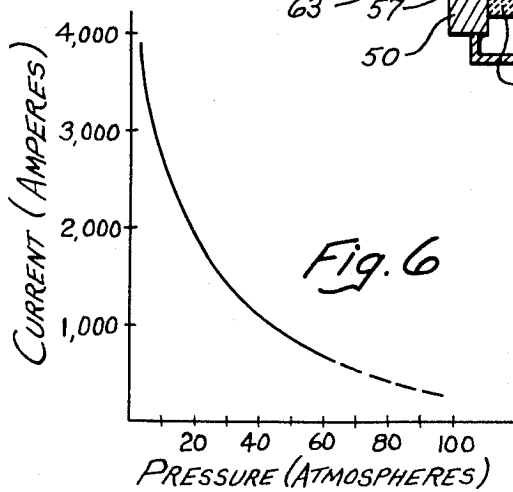


Fig. 6

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3,139,509

**ELECTRIC ARC TORCH**

James A. Browning, Hanover, N.H., assignor to  
Thermal Dynamics Corporation  
Filed May 7, 1962, Ser. No. 192,746  
4 Claims. (Cl. 219-75)

My invention relates to electric arc torches and relates more particularly to such torches in which plasma forming gases are used in conjunction with an electric arc to provide a source of extremely high temperatures.

Plasma torches conventionally consist, basically, of two electrodes between which an arc column is established. Gas is made to flow along the arc column, and is thereby heated, often to the plasma state. Such devices may be used for cutting, plating of fused materials, chemical synthesis, wind tunnel re-entry simulation, and variety of other commercial and experimental applications.

Prior arc torches of the type under discussion have utilized a flow geometry in which all the gas flows uni-directionally through the nozzle passage from the cathode, or electron emitting electrode. A device of this general type is exemplified by U.S. Patent No. 3,027,446, issued March 27, 1962, to James A. Browning et al.

Such a uni-directional flow pattern presents some inherent problems. In particular, any electrode erosion (and erosion is almost always present) serves to contaminate the effluent plasma. Secondly, gas flowing in a single axial direction often cannot be made as effective use of as two directional gas streams.

My invention, therefore, is directed to providing an improved electric arc torch in which the gas stream is divided to flow in opposite directions. For the particular advantages accruing from such a novel arrangement, and for a better understanding of the invention, reference to the following detailed description and accompanying figures should be made. In the figures:

FIGURE 1 is a schematic view, partly in section, of a torch embodying the principle of the invention;

FIGURE 2 is a torch, in section, in which the invention is applied to the transferred mode of operation;

FIGURES 3a and 3b are simplified schematic views of electric arc torch elements to explain the mechanism of gas stabilization;

FIGURE 4 illustrates still another embodiment of the invention using two hollow electrodes;

FIGURE 5 is a view, in section, of a torch employing the invention to provide a supersonic jet stream; and

FIGURE 6 is a graph plotting current in amperes against pressure in a device of the type shown in FIGURE 5.

Referring now more particularly to the drawings, the torch of FIGURE 1 employs two nozzle sections 10 and 11. They may be separated by a ceramic swirl ring 12. The ring 12 is employed to impart a vortex flow of gas introduced to the torch through aperture 13 as shown. The action of ring 12 is fully explained in U.S. Patent No. 3,027,446, issued March 27, 1962, to the present inventor. In this case, however, the swirling gases divide at the ring 12, a portion entering the nozzle 10 and a portion entering the nozzle 11.

An arc is established between the nozzle 10 and a cathode 14 by means of a suitable power supply 15. The arc is stabilized and contained by the gases flowing as described above. The arc electrons are emitted at the arc spot 16 on the cathode 14, which is preferably made of a refractory material. The gas is heated by the arc and issues from the nozzle 10 in the form of a plasma flame 17. However, it is clearly evident that the gas flowing toward the cathode 14 (through nozzle 11) is also heated. The heat in this counter-flowing stream must be considered lost, and it is therefore advisable to

2

minimize the percentage of total available heat entering such stream. Accordingly, I keep the length of nozzle 11 to a minimum. The major voltage drop thus occurs along the arc in the direction of flow in the nozzle 10.

In any torch, erosion of the cathode occurs at a rate depending on torch design, power levels operated, and other factors. The eroded cathode material invariably forms a part of the effluent in prior arc torches. In many applications a pure, electrically neutral plasma flame is desired. In the torch of FIGURE 1 the divided portion of the gas stream which travels toward the cathode 14 carries contaminants out and away from the working end of the device represented by nozzle 10. Furthermore, the cathode spot 16 operates in a region of relatively low pressure with attendant advantages discussed below in connection with FIGURE 6.

In FIGURE 2, a torch is shown having two nozzles 20 and 22. In this case, the swirl ring 12 again divides the gas stream, with the "working portion" flowing through nozzle 22 toward a workpiece 23 to which heat is being applied. The workpiece 23 acts as the cathode. It should be pointed out here that the torch of FIGURE 2 is operating in what is called the transferred mode, in which the arc is not wholly contained within the torch as in FIGURE 1.

The necessity of providing this double flow of gas is better understood by an appreciation of the mechanism of gas-stabilization of an arc within a passage. The FIGURES 3a and 3b are identical except for the direction of gas flow. Let it be assumed that an arc length as shown strikes from cathode 25 to point A, and that this arc length is desired. In FIGURE 3a, the gas flow (shown by the arrows) tends to sweep the arc further down in the nozzle passageway toward point C. This tends to lengthen the arc, thus tending to increase the arc voltage. An essentially stable condition is thus created and a balance between gas action and arc voltage is maintained.

In FIGURE 3b, on the other hand, gas flow (again shown by arrows) tends to drive the arc towards point B. The arc column length drops and the condition is unstable. Thus it is seen that gas passing through an arc region must flow in that direction which tends to increase the arc voltage. Referring again to FIGURES 1 and 2, the situation is arranged in both cases so that in the nozzle passage where the arc strikes to the passage wall, the gas is flowing in the direction which produces arc stability.

In the case of FIGURE 2 this permits use of the workpiece 23 as the cathode, and substantially no cathode material contaminant can enter the torch body due to the direction of gas flow. Also, reactive gases, such as air or other mixtures containing oxygen may be used with torch deterioration being kept at a minimum. Cathode deterioration, where the cathode is a workpiece being cut, may actually be desirable, and the dual directional flow of gas provided by my invention makes this advantage also realizable.

In FIGURE 4 I provide a torch with two nozzles 30 and 32 of equal length. An arc is established as shown by a suitable power supply 34 which may be A.C. or D.C. current. A swirl ring 36 shapes the incoming plasma forming gas into two diverging vortices. With the principles discussed in connection with FIGURES 3a and 3b in mind, it will be seen that the flow in the two opposite directions provides a stable arc running from point X to point Y. The useful effluent of the torch of FIGURE 4 is divided into two parts, of course, represented by flames 38 and 40. This is of no moment in some applications, such for example as in the use of heat for chemical synthesis. If desired, curved nozzle passages may be employed thus combining the two flames of FIGURE 4 into one.

An additional feature of the multi-flow design is its ability to operate at extremely high gas pressures. The major limitation on prior high pressure arc torch operation has been electrode erosion. Using the principles of my invention, the electrodes may be placed outside the region of high pressure. This can be best appreciated from a study of FIGURE 5.

In FIGURE 5, a torch is used to create a supersonic jet stream for introduction into an evacuated chamber. Hollow electrodes 50 and 51 are electrically and geometrically separated and positioned by a ceramic piece 52. The piece 52 also serves as the gas injector and has a tangentially disposed injector hole 55 as shown. Gas is introduced through the manifold piece 53 via hole 54. The gas splits into two streams within the torch. One portion flows towards a supersonic nozzle section 58 and is discharged into the vacuum chamber 60 to form a supersonic jet 61.

The remaining gas flows in the opposite direction through hole 57 in piece 50. Assuming piece 50 to be serving as the negative, or cathode, electrode, the arc is seen to issue to form the fountain geometry 63. The cathode spot 64 is contained in an environment of much lower pressure than would be experienced within the torch body, thus allowing for the use of much higher amperages.

In FIGURE 5 the arc column strikes the anode within the high-pressure region. Anode action, however, is less prone to high-pressure difficulties. In severe cases the geometry of the nozzle at 58 can be changed to provide for arc passage through the nozzle to strike and terminate in a fountain configuration in the low-pressure region beyond the nozzle opening. In any case it will be appreciated that my invention provides, in the case of FIGURE 5, the dual advantage of no cathode contamination of the useful effluent, and the operation of the electrodes in low pressure regions.

The benefits of this latter advantage can be seen from the graph of FIGURE 6. Here is shown actual experimental data of the effect pressure (in the cathode region) has on the allowable maximum current flow. Operation at 100 atmospheres is limited to less than 300 amperes. A device operating at such parameters would require an arc voltage drop of over 3000 volts to produce one megawatt of power. If the electrodes were to be operated at

approximately one atmosphere at 3000 volts torch output could be raised to 10 megawatts. Any reduction in electrode-region pressure is desirable and my dual flow invention makes this result a practicality.

While I have illustrated a few applications of the basic principles of my invention, these have been discussed by way of explanation; and within the spirit and scope of the following claims modifications and further applications may occur to those skilled in this art.

I claim:

1. A transferred arc torch comprising a nozzle shaped electrode having an arc passage, means for establishing an arc between a work piece and said electrode, and gas means for stabilizing said arc in said passage with gas directed from a point along said passage toward said work piece and simultaneously toward the terminal point of said arc on said electrode.

2. A double-ended electric arc torch comprising a pair of nozzle shaped electrodes having arc passages therein, said electrodes being arranged with their nozzles on the same axis; means for establishing an arc within said passages and between said electrodes; and means providing a split gas flow from a point between said electrodes into both said passages to stabilize said arc.

3. A torch according to claim 2 in which said arc passages are curved such that the two effluents (from each end of said torch) are directed less than 180 degrees apart.

4. An electric arc torch comprising a first electrode in annular form, a second elongated electrode having a nozzle passage, a gas swirl ring of insulating material separating said electrodes, means for establishing an arc between said electrodes, and means for introducing gas to flow in opposite directions from said swirl ring into said passage and through said first electrode.

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- [54] **LENS PIPE ARC LAMP**
- [75] **Inventors:** Roy D. Roberts, Newark; Norman L. Young, Felton, both of Calif.
- [73] **Assignee:** ILC Technology, Inc., Sunnyvale, Calif.
- [21] **Appl. No.:** 97,255
- [22] **Filed:** Sep. 17, 1987

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*Primary Examiner*—Theodore M. Blum  
*Assistant Examiner*—Gregory C. Issing  
*Attorney, Agent, or Firm*—Thomas E. Schatzel

**Related U.S. Application Data**

- [63] Continuation-in-part of Ser. No. 901,800, Aug. 29, 1986, abandoned.
- [51] **Int. Cl.<sup>4</sup>** ..... H01J 17/26; H01J 61/28
- [52] **U.S. Cl.** ..... 313/231.61; 313/231.71
- [58] **Field of Search** ..... 313/111, 231.71, 231.61, 313/231.41; 350/96.18, 96.26, 96.34, 96.23

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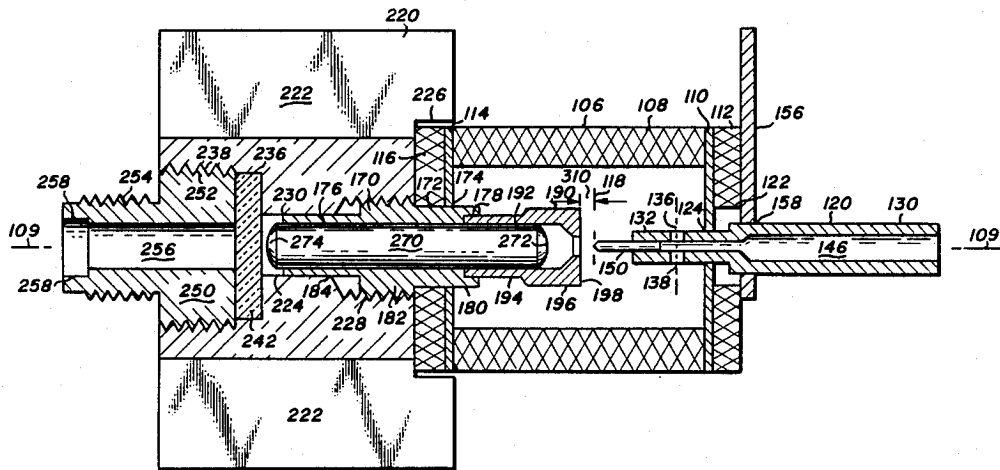
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[57] **ABSTRACT**

An arc discharge light pipe comprised of a sapphire light pipe, a cathode, and an anode. The anode is a hollow cylinder with an end cap having an aperture therein. The pointed cathode and the end cap of the anode form an arc gap which produces a conical arc discharge. The light from the conical arc discharge passes through the aperture into the hollow anode. The sapphire light pipe is positioned inside the hollow anode to collect the light and focus it on a desired point.

**15 Claims, 4 Drawing Sheets**



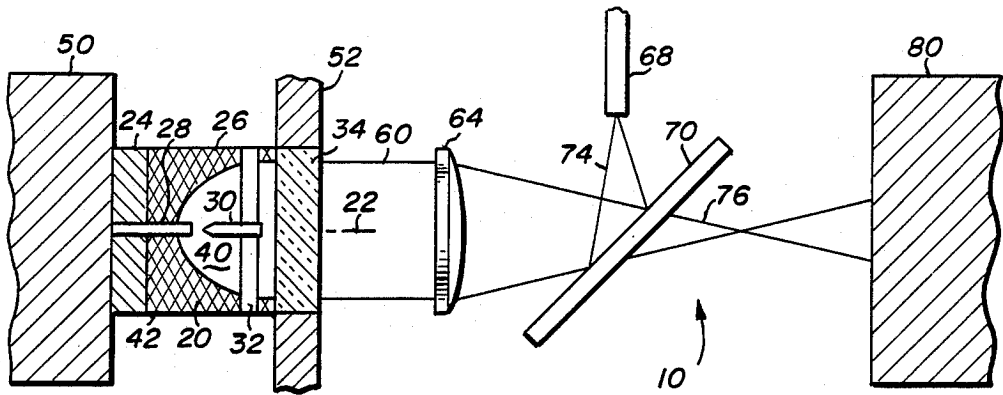


Fig. 1 PRIOR ART

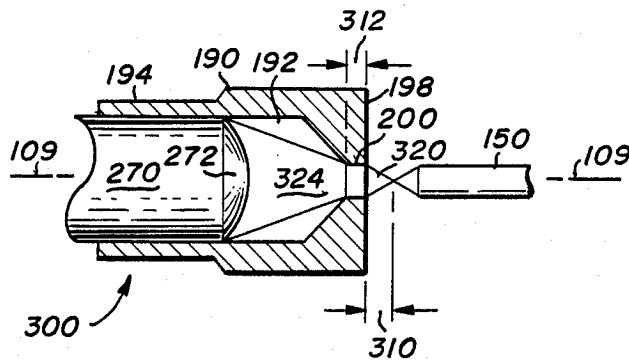


Fig. 3

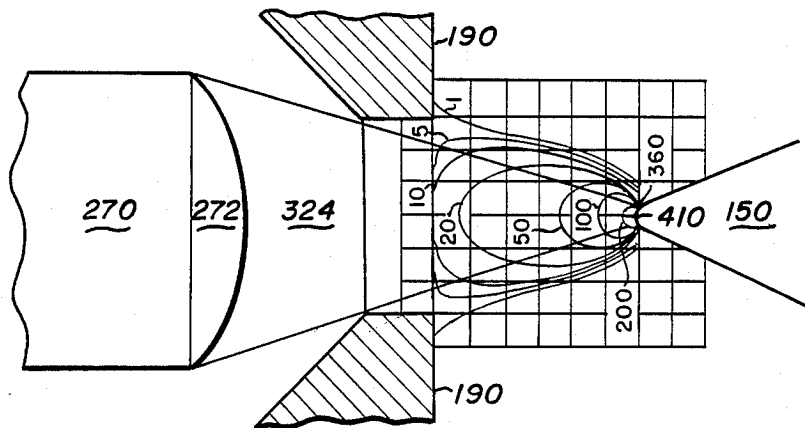


Fig. 4





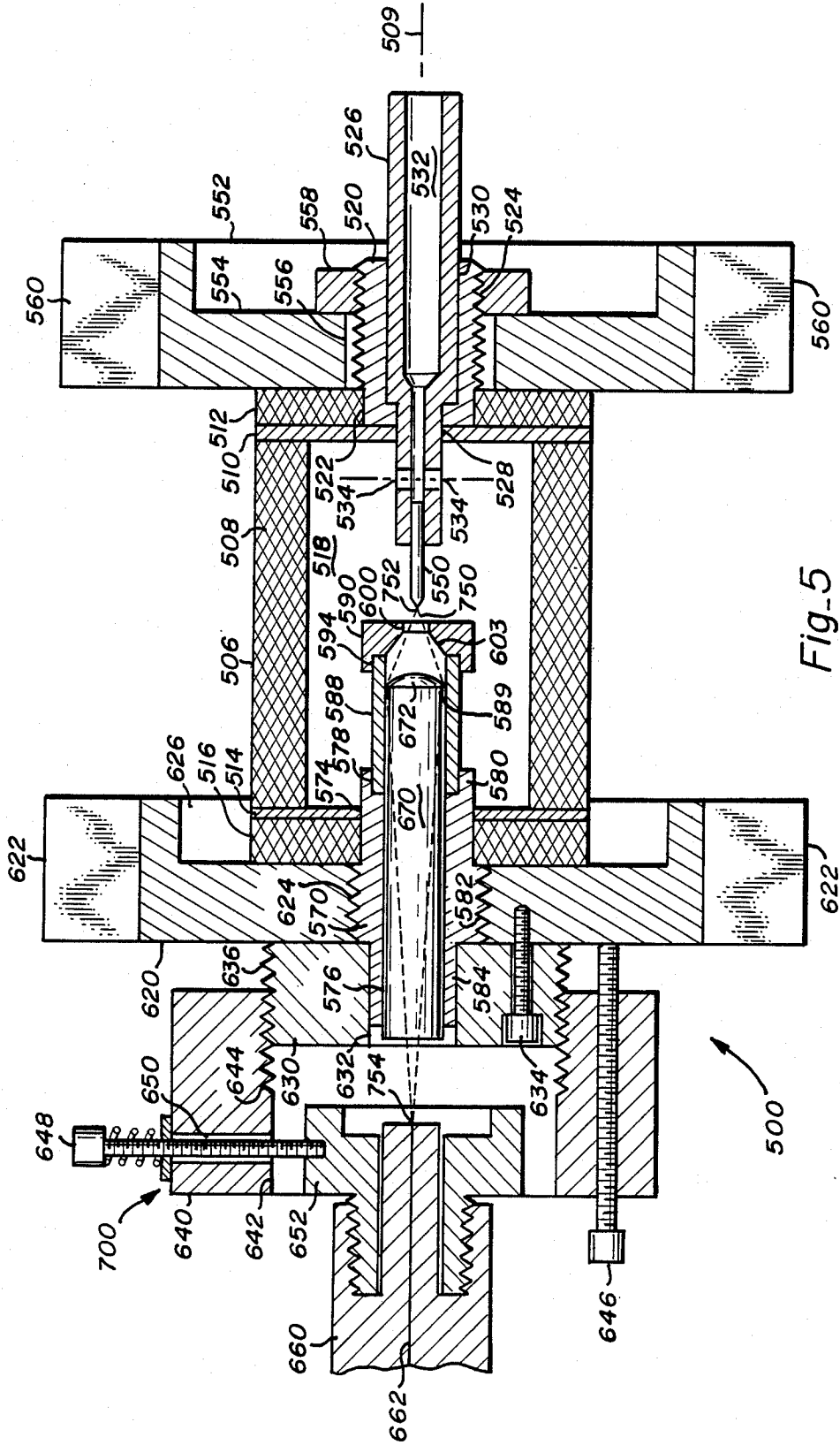


Fig. 5

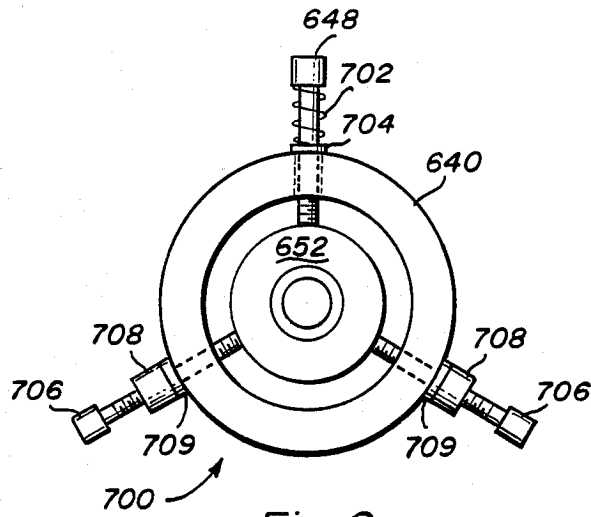


Fig. 6

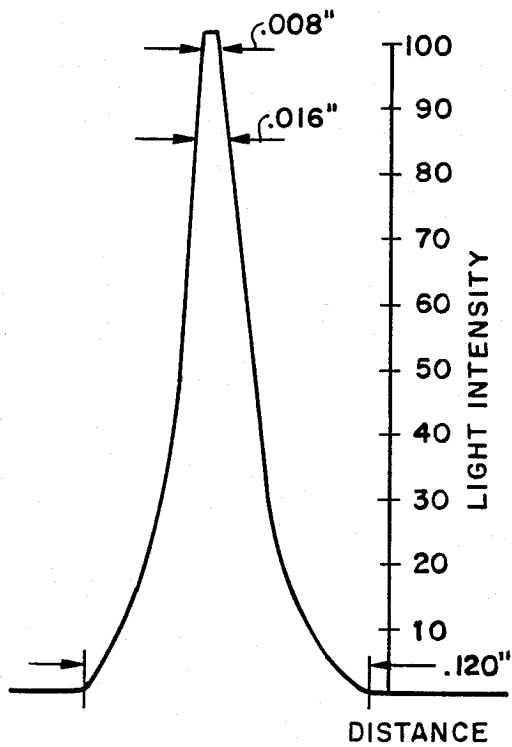


Fig. 7

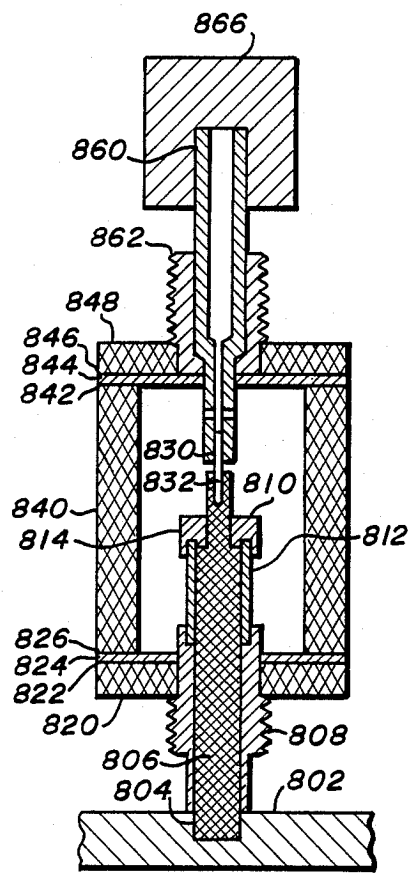


Fig. 8

## LENS PIPE ARC LAMP

This is a continuation-in-part of co-pending application Ser. No. 901,800 filed on 8/29/86 now abandoned.

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The invention relates generally to arc lamps and more particularly to arc lamps for use with fiber optic bundles.

## 2. Description of the Prior Art

Arc lamps are used to provide intense point sources of light for applications such as instrumentation and projection. Medical endoscopes are one type of application. In endoscopes, the arc lamps serve as illuminators of fiber optic bundles that allow visual examination of the body canals and adjacent organs without conventional surgery. Arc lamps are also used in industrial endoscopes to examine structures and components which are difficult to inspect visually, such as the interiors of jet engines.

Recently, medical science has started to use fiber optic bundles to examine smaller body canals, such as the coronary arteries. In order to achieve this, the fiber bundles cannot exceed one millimeter in diameter. In the past, fiber bundles have been at least four millimeters in diameter. In order to achieve fiber bundles of less than one millimeter in diameter, each individual fiber cannot exceed two hundred microns in diameter. It is thus necessary to have a light source which can provide a highly intense point of light to a fiber of two hundred microns or less.

A typical prior art arc lamp system for use with a fiber optic bundle is shown in FIG. 1 and is designated by the general reference number 10. An arc lamp 20 is generally symmetrical about an axis 22 and includes a base 24, a body 26, an anode 28, a cathode 30, a plurality of cathode support arms 32 and a window assembly 34. The base 24 is generally formed out of iron. The body 26 is usually made of a ceramic material.

The body 26 includes a concave cavity 40 which defines a curved reflective surface 42. Reflective surface 42 has a reflective metal coating deposited thereon. Anode 28 passes from the base 24 through the body 26 and extends from the back of reflective surface 42 into cavity 40 along axis 22. Cathode support arms 32 extend radially from body 26 toward axis 22. Cathode 30 is mounted to support arms 32 along axis 22. The window 34 fits sealingly against body 26 so that cavity 40 is gas tight. Window 34 is made of a transparent material. In operation, the cavity 40 is filled with an inert gas, such as xenon, at a pressure of several atmospheres. The lamp is illuminated when a breakdown voltage is present across the arc gap, thereby resulting in an illuminating flow of electrons (i.e., arc discharge) across the gap from the cathode 30 to the anode 28. Typically, such lamps operate from about one hundred fifty to eight hundred watts.

A first heat sink 50 is attached to base 24. Heat sink 50 absorbs the heat from base 24. A second heat sink 52 is attached to window 34 to draw off heat generated in the window 34.

The light 60 emerges from arc lamp 20 and passes through a lens 64. Lens 64 is needed to concentrate light 60 into a beam small enough for use with a fiber optic bundle 68. Before light 60 enters bundles 68, it is filtered by a cold mirror 70. Cold mirror 70 reflects visible light

74 to bundle 68, but allows infrared light to pass through to a third heat sink 80. Heat sink 80 dissipates the heat from infrared light 76.

There are several problems with this prior art system. One problem is that the system is bulky and involves a large number of components. Another problem is that the positioning of such components as the reflector 42, with respect to the cathode 30, lens 64, and mirror 70 must be exact. Even slight deviations in the alignment of these components can be critical. Another problem is that the reflector forms holes in the beam of light. These beam hole patterns in the light prevent the generation of a uniform light source.

Another prior art system is shown in U.S. Pat. No. 3,770,338, by James Helmuth. A light conducting pipe is inserted into an arc lamp envelope perpendicular to the electrodes. The light conducting pipe gathers light from the entire arc plume. However, the plume is not uniform in intensity and therefore, the light collected is asymmetrical. In addition, the light provided is not a highly focused intense point of light needed for optical fibers of two hundred microns or smaller.

## SUMMARY OF THE PRESENT INVENTION

It is therefore an object of the present invention to provide a fiber optic arc lamp which is compact in size.

It is a further object to provide a fiber optic arc lamp which does not require the use of a reflector.

It is another object to provide a fiber optic arc lamp which does not have beam hole patterns.

It is another object of the present invention to provide an arc lamp which can image a high intensity point source of light energy into a fiber optics light guide bundle having a typical diameter between fifty and two hundred microns.

It is a further object to provide a fiber optic arc lamp with direct imaging of the arc's hot spot into a light guide conduit without the intermediate reflector stage.

It is another object to provide a fiber optic arc lamp where improved spatial qualities are achieved by directly imaging the lamp's arc hot spot using a small diameter light guide in close proximity to the source, wherein the diameter of the light guide can be matched to the size of the plasma arc.

Briefly, in a preferred embodiment, the present invention includes a ceramic body having a cylindrical cavity formed therein containing pressurized gas. A cathode is mounted to extend through a first end of the body along an axis of the cylindrical cavity. The cathode is rod-shaped with a distal end tapered to a point and the distal end extends into the cavity. An anode is mounted to extend through a second end of the body and extends along the axis of the cylindrical cavity. The anode is a hollow cylinder. The distal end of the anode extends into the cavity and has an end cap. The tapered end of the cathode and the end cap of the anode form an arc gap. The end cap of the anode has an aperture.

A cylindrical sapphire light pipe is sized to fit inside the hollow anode and passes from inside the cavity to outside the body. Light from the arc gap passes through the aperture in the anode and hits the sapphire light pipe. The pipe has a curved end surface opposite the aperture to focus the light from the arc hot spot. This small high intensity point of light is imaged onto a fiber optic bundle outside the body.

An advantage of the present invention is that it provides a fiber optic arc lamp which is compact in size.

It is a further advantage of the present invention in that it provides a fiber optic arc lamp which does not require the use of a reflector.

It is another advantage of the present invention in that it provides a fiber optic arc lamp which does not have beam hole patterns characteristic of arc lamps with reflector optics.

It is another advantage of the present invention, to provide an arc lamp which can image a high intensity point source of light energy into a fiber optics light guide conduit having a typical diameter of between fifty and two hundred microns.

It is a further advantage in that it provides a fiber optic arc lamp with direct imaging of the arc's hot spot into a light guide conduit without the intermediate reflector stage.

It is another advantage in that it provides a fiber optic arc lamp where improved spatial qualities are achieved by directly imaging the hot spot using a small diameter light guide in close proximity to the source, wherein the diameter of the light guide can be matched to the size of the plasma arc.

These and other objects and advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiment which is illustrated in the various drawing figures.

#### IN THE DRAWINGS

FIG. 1 is a cross-sectional view of an arc lamp of the prior art as previously discussed;

FIG. 2 is a cross-sectional view of an arc discharge light pipe of the present invention;

FIG. 3 is a cross-sectional view of a portion of the arc discharge light pipe of FIG. 2;

FIG. 4 is a cross-sectional view of the arc discharge showing the light intensity distribution;

FIG. 5 is a cross sectional view of a second embodiment of the present invention;

FIG. 6 is a side view of an adjustable connector of FIG. 5;

FIG. 7 is a graph of a beam scan of the present invention; and

FIG. 8 is a cross-sectional view of the invention of FIG. 5 during manufacture.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 2 shows an arc discharge light pipe of the present invention and is referred to by the general reference number 100. A body 106 is comprised of a ceramic cylinder 108 having an axis 109, a cathode inner ring 110, a cathode back-up ring 112, an anode inner ring 114, and an anode back-up ring 116. The inner rings 110 and 114 are made of a Kovar material and are copper brazed to the ends of the ceramic cylinder 108. The back-up rings 112 and 116 are made of a ceramic material. Back-up ring 112 is copper brazed to inner ring 110 and back-up ring 116 is copper brazed to inner ring 114. An air-tight cavity 118 is formed inside cylinder 108.

A cathode support 120 is passed through an aperture 122 of back-up ring 112 and an aperture 124 of inner ring 110 along axis 109. Support 120 is a hollow tube made of nickel. Support 120 has a section 130 having a diameter greater than aperture 124, but less than aperture 122, and a section 132 which has a diameter approximately equal to aperture 124. Section 32 extends into cavity 118. Support 120 is copper or silver brazed to

inner ring 110. A pair of gas venting holes 136 and 138 pass perpendicularly through section 132 of support 120 and intersect the inner surface of support 120. The inner surface of support 120 defines a passageway 146.

A cathode 150 extends from support 120 along axis 109. Cathode 150 is rod-shaped and fits partially inside passageway 146. Cathode 150 is made of tungsten and is brazed to support 120. The distal end of cathode 150 is tapered to a point at an angle of approximately fifty degrees relative to axis 109.

A tab 156 is copper brazed to cathode support 120. The tab 156 is a flat steel strip with a hole 158 at one end. Hole 158 is sized such that section 130 of cathode support 120 fits through it. Tab 156 extends beyond the outer edge of back-up ring 112 perpendicularly to axis 109.

An anode support 170 is passed through aperture 172 of back-up ring 116 and aperture 174 of inner ring 114 along axis 109. Anode support 170 is a hollow tube made of Kovar material. Support 170 has an inner passageway 176 and a countersunk section 178. Support 170 has an anode section 180 which has a diameter approximately equal to aperture 172 and 174, a screw section 182 which has a diameter greater than anode section 180 and a rear section 184 which has a diameter less than anode section 180. Support 170 is copper or silver brazed to inner ring 114.

An anode 190 is made of tungsten and shaped like a hollow cylinder with an inner passageway 192. Passageway 192 is the same diameter as passageway 176 of support 170. Anode 190 has a support section 194 which has a diameter approximately equal to countersunk section 178 of support 170. Anode 190 is positioned along axis 109 with support section 194 partially fitting inside countersunk section 178. Anode 190 is copper brazed to support 170. Anode 190 has an arc section 196 which has a diameter greater than support section 194. Anode 190 has an end cap 198 at the end of arc section 196. An aperture 200 passes through end cap 198 along axis 109. Aperture 200 has a smaller diameter than passageway 192. Passageway 192 is tapered at a forty-five degree angle to axis 109 to meet aperture 200.

A heat sink 220 is cylindrically shaped and has a plurality of fins 222 extending radially outward from the side of the cylindrical section. Heat sink 220 is made of aluminum. Heat sink 220 is positioned along axis 109. An inner passageway 224 is symmetrical about axis 109. A countersunk section 226 allows heat sink 220 to fit around the outer edge of back-up ring 116. A screw section 228 of passageway 224 mates with screw section 182 of support 170. A section 230 of passageway 224 has a diameter approximately equal to rear section 184 of support 170 such that rear section 184 fits inside section 230. A filter section 236 of passageway 224 is located behind section 230 along axis 109 and has a diameter greater than section 230. A connector screw section 238 of passageway 224 is located along axis 109 behind section 236.

A heat absorbing filter 242 is positioned inside section 236 of heat sink 220. Filter 242 is disk-shaped and made of glass. A cylindrical fiber optic connector 250 has a screw section 252 which mates with screw section 238 of heat sink 220. Connector 250 has a screw section 254 for mating with a fiber optic bundle. Connector 250 has an inner passageway 256 symmetrical about axis 109 which has a diameter approximately equal to passageway 176 of anode support 170. A pair of slots 258 are located in passageway 256 at the outer end of screw

section 254 for connecting with a fiber optic bundle. Connector 250 is made of aluminum.

A cylindrical sapphire light pipe 270 is positioned inside passageway 176 of support 170 and passageway 192 of anode 190. The diameter of pipe 270 is approximately equal to the diameter of passageways 176 and 192. Pipe 270 should be long enough to allow heat from anode 190 to dissipate before reaching fiber optic connector 250. Pipe 270 has a curved surface 272 at one end to focus light. A second curved surface 274 may be provided at the other end to further focus the light.

FIG. 3 shows the arc gap section of arc discharge light pipe 100 and is referred to by the general reference number 300. Cathode 150 has a diameter of 0.032 inches and aperture 200 has a diameter of 0.031 inches. An arc gap 310 from the tip of cathode 150 to anode 190 is 0.020 inches. Aperture 200 extends a distance 312 of 0.015 inches deep.

In operation, the cavity 118 is filled with xenon gas to seventeen atmospheres through passageway 146 of cathode support 120 and then the passageway 146 is sealed. Light is produced when the breakdown voltage is exceeded across arc gap 310. Typical breakdown voltage is 25,000 volts. The flow of electrons across the gap from cathode 150 to anode 190 creates an arc discharge or plasma 320 which is cone-shaped. The conical arc discharge 320 produces a stream of light 324 inside passageway 192 of anode 190. Aperture 200 functions as a light guide.

Light pipe 270 is positioned in passageway 192 such that the light 324 is distributed across its end surface 272. Surface 272 is curved to focus the light through light pipe 270 and filter 242 to a fiber optic bundle held in fiber optic connector 250. The filter 242, absorbs infrared heat and dissipates it through heat sink 220. Surface 274 provides further focusing of the light and allows the light to be focused on very small diameter fiber optic bundles (50 microns in size).

The present invention does not need a bulky reflector to gather light because the light pipe 270 is positioned near arc gap 310. The unique placement of the light pipe 270 in anode 190 makes the most efficient use of the light generated by the conical arc discharge 320.

FIG. 4 shows a cross-sectional view of the arc discharge with the light intensity distribution. Each line represents constant luminous intensity measured in candelas per square millimeter. The curved surface 272 is focused on the hottest and most intense light region of the arc, which is a point 410 at the tip of cathode 150.

FIG. 5 shows a second embodiment of an arc discharge light pipe of the present invention and is referred to by the general reference number 500. A body 506 is comprised of a ceramic cylinder 508 having an axis 509, a cathode inner ring 510, a cathode back-up ring 512, an anode inner ring 514, and an anode back-up ring 516. The inner rings 510 and 514 are made of a Kovar material and are copper brazed to the ends of the ceramic cylinder 508. The back-up rings 512 and 516 are made of a ceramic material. Back-up ring 512 is copper brazed to inner ring 510 and back-up ring 516 is copper brazed to inner ring 514. An air tight cavity is formed inside cylinder 508. The cylinder 508 is 0.56 inches long, 0.10 inches thick and has a diameter of 0.63 inches. The inner rings 510 and 514 are 0.02 inches thick and the back-up rings 512 and 516 are 0.075 inches thick.

A cathode holder 520 is passed through an aperture 522 of back-up ring 512. Holder 520 is copper or silver brazed to inner ring 510. The holder 520 is a hollow

cylinder made of Kovar material and has a thread screw section 524. A cathode support 526 is passed through an inner passage 530 of cathode holder 520 and an aperture 528 of inner ring 510. Support 526 is a hollow tube made of nickel and has an inner passage 532. Support 526 is copper or silver brazed to holder 520. A pair of gas vent holes 534 pass through support 526 and intersect passage 532.

A cathode 550 extends from support 526 along axis 509. Cathode 550 is rod shaped with a diameter of 0.03 inches and fits partially inside passageway 532. Cathode is made of tungsten and is brazed to support 526. The distal end of cathode 550 is tapered to a point of an angle of approximately fifty degrees relative to axis 509.

A cylindrical heat sink 552 has a countersunk section 554 and a central aperture 556. The aperture 556 is sized to fit around holder 520 such that heat sink 552 abuts back-up ring 512. A nut 558 mates with screw section 524 and holds heat sink 552 in place. A plurality of fins 560 extends radially outward. Heat sink 552 is made of gold anodized aluminum.

An anode support 570 is passed through an aperture 572 of back-up ring 516 and an aperture 574 of inner ring 514 along axis 509. Anode support 570 is a hollow tube made of Kovar material. Support 570 has an inner passageway 576 and a countersunk section 578. Support 570 has an anode section 580 which has diameter approximately equal to aperture 572 574, a screw section 582 which has a diameter greater than anode section 580 and a rear section 584 which has a diameter less than anode section 580. Support 570 is copper or silver brazed to inner ring 514.

A cylindrical molybdenum sleeve 588 fits into section 578 of support 570 and is copper or silver brazed in place. Sleeve 588 has an inner passage 589. An anode is made of tungsten and shaped like a hollow cylinder and has diameter of 0.018 inches. Anode 590 has a countersunk section 594 shaped to fit over end of the sleeve 588. Anode 590 is positioned along axis 509. Anode 590 is platinum brazed to sleeve 588. An aperture 600 passes through anode 590 along axis 509 and has a diameter of 0.03 inches and is 0.015 inches deep. Aperture 600 has a smaller diameter than passageway 589. A tapered section 602 tapers at a forty-five degree angle to axis 109 to meet aperture 600 from passageway 589. Anode 590 is located 0.02 inches from the tip of cathode 550.

A heat sink 620 is cylindrically shaped and has plurality of fins 622 extending radially outward from the side of the cylindrical section. Heat sink 620 is made of gold anodized aluminum. Heat sink 620 is position along axis 509. An inner screw thread passage 624 is symmetrically located about axis 509 and mates with screw thread section 582 of anode support 570. A countersunk section 626 allows heat sink 620 the fit around the outer edge of back-up ring 516.

A stainless steel cylindrical plate 630 has an aperture 632 sized to fit around rear section 584 of anode support 570. The plate 630 is attached to heat sink 620 by means of a plurality of screws 634 (only one of which is shown). Plate 630 has a thread screw section 636 around its outer circumference.

An adjustment cylinder 640 has an internal aperture 642. Cylinder 640 is made of Delrin material. The Delrin material acts as a heat shield. A portion of aperture 642 has a screw thread section 644 which mates with screw section 636 of plate 630. A stop screw 646 passes through cylinder 640 parallel to axis 509 and abuts heat sink 620. A screw 648 passes through a radial aperture

650 of cylinder 640 and screws into connector 562. Two other screws (not shown), in addition to screw 648, are equally spaced around cylinder 640 and screw into connector 652. A standard SMA fiber optic connector 666 mates with connector 652. Connector 666 contains an optic fiber 662 which is two hundred microns or less in diameter.

A cylindrical sapphire light pipe 670 is positioned inside passageway 576 of support 570 and passageway 589 of sleeve 588. The diameter of pipe 670 is approximately equal to the diameter of passageway 576 and 589, or about 0.12 inches. Pipe 570 has a curved surface 572 located behind anode 590. The curved surface has radius of curvature of 0.114 to 0.116 inches. Pipe 570 is 0.630 inches long.

FIG. 6 shows a side elevation view of the adjustable connector of FIG. 5 and is referred to by the general reference number 700. Screw 648 has a spring 702 and a washer 704 between its head and cylinder 640. Two other screws, 706, are spaced an equal distance apart from each other and screw 640. Screws 706 pass through cylinder 640 in a radial direction and screw into connector 652. Each of screws 706 has an adjustment nut 708 and a washer 709. Spring 702 tends to pull connector 752 in an upward direction. By adjusting nut 708, the connector 652 can be moved in an up or down or side-to-side direction relative to cylinder 640. This movement is in a plane perpendicular to axis 509.

Returning now to FIG. 5, in operation, the cavity 518 is filled with Xenon gas to seventeen atmospheres pressure through passageway 532 of cathode support 526 and then the passage 532 is sealed. Light is produced when the breakdown voltage is exceeded across the arc gap. Typical breakdown voltage is 25,000 volts. The flow of electrons crossing the gap from cathode 550 to anode 590 creates an arc discharge or a plasma 750 which is of a hollow cone shape. See also FIG. 4.

At the tip of cathode 550, a hot spot 752 exists which is the hottest and brightest point in plasma 750. See FIG. 4. Light pipe 670 is located about 0.180 inches from hot spot 752. The surface 672 is shaped to focus the image of the hot spot 752 to point 754 a distance of 0.050 to 0.0100 inches behind light pipe 670. By using adjustment connector 700, the fiber 662 is moved until its end meets point 754. By rotating cylinder 640 along screw section 636, the fiber can be moved along axis 509. By adjusting nuts 708, the fiber can be moved in a plane perpendicular to axis 509. Thus, the present invention directly images the bright and small point of light from hot spot 752 directly into a small fiber 662 of two hundred microns or less in diameter. Since pipe 670 is focused only on point 752, the other less bright portions of the plasma 750 are ignored. The typical light pipe transfers light by reflecting off the side walls. This decreases the intensity of the light. Here the light is not reflected off the walls, but a point source is being directly imaged. Only the end surfaces of the light pipe 670 need to be polished. The side walls of light pipe of 670 do not need to be polished.

FIG. 7 shows a graph of a beam scan using the present invention. A light detector with an aperture of 0.015 inches was moved in a line perpendicular to axis 509 at point 754. The light pipe 570 has a diameter of 0.120 inches. At point 754 the light intensity reaches a sharp maximum, this is the image of the hot spot 752 of plasma 750. Note also that because the light pipe is located directly inside an behind the plasma cone 750, the light intensity pattern is symmetrical. The present invention

is able to provide a very small, but intense point of light directly to a very small optic fiber.

FIG. 8 shows a cross sectional view of a light pipe arc lamp of the present invention during manufacture and is designated by the general reference number 800. A stainless steel base 802 provides support. A counter bore 804 holds a ceramic jig 806. An anode support 808 is placed on jig 806. Next, an anode assembly 810 is placed on ceramic support 808. Anode assembly 810 is comprised of a sleeve 812 and an anode 814 which have been previously attached by means of a platinum braze.

Next, a back-up ring 820, a braze washer 822, an inner ring 824, and a braze washer 826 are all placed on anode support 808. A cathode 830 is placed inside a hole 832 in jig 804. A body 840 is placed on braze washer 826. A braze washer 842, an inner ring 844, a braze washer 846 and a back-up ring 848 are then placed on body 840. A cathode support 860 and a cathode holder 862 are then placed on inner ring 844 and the cathode support 860 extends through inner ring 844 and receives cathode 830. A weight 866 may then be attached to the top of cathode support 860 to hold the cathode support 860 and the cathode 830 securely in place. The entire assembly 800 is then brazed in a one step operation.

The weight 866 and jig 804 are the removed from assembly 800. A light pipe (not shown) is then brazed inside anode support 808 and sleeve 812.

The unique design of the lamp of this invention lends itself to this simple method of manufacture. The hole in the anode can be used by the jig 804 to insure that the cathode is located in precisely the right position relative to the anode. Thus, the lamp of the present invention can be manufactured in large quantities with a high degree of precision in the alignment of each and every one.

Although the present invention has been described in terms of the presently preferred embodiment, it is to be understood that such disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

We claim:

1. A lens pipe arc lamp comprising:

a body formed of a dielectric material having formed therein a hollow cavity containing pressurized gas; a pair of electrodes mounted within said cavity with the distal ends of said electrode being spaced apart a distance to define an arc gap;

a lens pipe means mounted to pass from outside the body through a wall of the body and into said cavity, with a fresh end having a lens surface positioned inside said cavity and a second end positioned outside the body, the lens surface having a first focal point located at a light point proximate the distal end of one of the electrodes said light point having the highest light intensity of an arc discharge of said arc gap and a second focal point located beyond said second end of said lens pipe means, the lens pipe means for direct imaging of light from said light point to said second focal point without reflection off of the inner surface of the lens pipe means; and

an optic fiber connector attached to the body and positioned such that an optic fiber held in the optic

fiber connector is positioned proximate said second focal point to receive said imaged light.

2. The device of claim 1 wherein, said lens pipe means is made of sapphire, said first end and said second end having polished surface and said lens pipe means having side surfaces which are unpolished.

3. The device of claim 1 wherein, one of the electrodes is a cathode member, mounted to a wall of the body, said cathode member having its distal end tapered to a point; and the other of the electrodes is a anode member mounted to a wall of said body, said anode member sized to fit over the first end of said lens pipe means, the distal end of said anode having an aperture to allow passage of light from said first focal point to the lens pipe means said distal end of said anode together with said point of said cathode forming said arc gap.

4. The device of claim 3 further including, a first heat sink attached to said anode and a second heat sink attached to said cathode.

5. The device of claim 1 wherein, the electrodes and the lens pipe means are positioned along an axis.

6. The device of claim 1 further including, a heat absorbing filter positioned at said second end of said lens pipe means.

7. The device of claim 36 further including, a heat sink attached to the body and the filter.

8. A lens pipe arc lamp comprising:  
 a body made of a dielectric material having a cavity filled with pressurized gas;  
 a cathode mounted about a first end of said cavity and extending into said cavity along an axis, and having a distal end tapered to a point;  
 an anode mounted about a second end of said cavity and extending into said cavity along said axis, the anode having an inner passageway extending outside the body and an end portion at its distal end, an aperture passing through said end portion along said axis, the distal end of the anode and cathode spaced a distance apart to define an arc gap, an arc discharge of said arc gap being of a conical shape with said aperture located at a base of said conical shaped arc discharge;

a sapphire lens pipe means sealably mounted inside said passageway along said axis and having a lens surface along a first end located opposite said aperture and a second end positioned outside the body, the lens pipe means having a first focal point located at a light point proximate said distal end of the cathode, said light point having the highest light intensity of said arc discharge and a second focal point located beyond said second end of said lens pipe means, the lens pipe means for direct imaging of said light point to said second focal point without reflection off the inner surface of the lens pipe means; and

an optic fiber connector attached to the body and positioned such that an optic fiber held in the optic

fiber connector is positioned proximate said second focal point to receive said imaged light.

9. The device of claim 8 further including, a metallic heat sink attached to a portion of the anode which extend through said second end of said cavity outside the body, the heat sink having a heat sink passageway to receive the lens pipe means.

10. The device of claim 9 further including, a heat absorbing filter positioned inside said heat sink passageway at said second end of said lens pipe means to absorb heat.

11. The device of claim 8 wherein, the diameter of said anode passageway is greater than the diameter of said aperture, the diameter of said aperture being sized such that light from said light point falls across the entire surface area of said first end of said lens pipe means.

12. The device of claim 8 wherein, said second end of the lens pipe means has a lens surface to further focus the light from said light point.

13. The device of claim 8 further including, a first heat sink attached to said anode and a second heat sink attached to said cathode.

14. A lens pipe arc lamp comprising:  
 a body made of dielectric material having a cavity filled with pressurized gas;  
 a cathode mounted about a first end of said cavity and extending into said cavity along an axis, and having a distal end tapered to a point;  
 an anode mounted about a second end of said cavity and extending into said cavity along said axis, the anode having an inner passageway extending outside the body and an end portion at its distal end, an aperture passing through said end portion along said axis, the distal end of the anode and cathode spaced a distance apart to define an arc gap, an arc discharge of said arc gap being of a conical shape with said aperture located at a base of said conical shaped arc discharge;

a sapphire lens pipe means sealably mounted inside said passageway along said axis and having a convex surface along a first end located opposite said aperture and a second end positioned outside the body, the lens pipe means having a first focal point located at a hot spot of said arc discharge and a second focal point located beyond said second end of said lens pipe means, the lens pipe means for imaging said hot spot to said second focal point; and

an optic fiber connector attached to the body and positioned such that an optic fiber held in the optic fiber connector is positioned proximate said second focal point to receive said imaged hot spot light, the optic fiber connector has adjustment means to move the optic fiber in three axes of direction relative to said second focal point.

15. The device of claim 14 wherein, the optic fiber connector comprises a cylinder having a passageway and connected to the body by screw thread means, a fiber connector located within said passageway, a plurality of adjustment screws connecting said cylinder and said fiber connector.



US006448712B2

(12) **United States Patent**  
**Honda et al.**

(10) **Patent No.:** **US 6,448,712 B2**  
(45) **Date of Patent:** **Sep. 10, 2002**

(54) **HIGH-PRESSURE DISCHARGE LAMP**

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(75) Inventors: **Hisashi Honda; Seiji Ashida; Kiyoshi Saita**, all of Yokosuka; **Ariyoshi Ishizaki; Akira Itoh**, both of Yokohama; **Shigehisa Kawatsuru**, Yokosuka; **Tatsuo Otabe**, Tokyo, all of (JP)

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(73) Assignee: **Toshiba Lighting and Technology Corporation**, Tokyo (JP)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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International Search Report.

(21) Appl. No.: **09/759,675**

\* cited by examiner

(22) Filed: **Jan. 11, 2001**

**Related U.S. Application Data**

(62) Division of application No. 09/458,793, filed on Dec. 10, 1999, now Pat. No. 6,249,086, which is a continuation of application No. PCT/JP99/02014, filed on Apr. 15, 1999.

*Primary Examiner*—Vip Patel

*Assistant Examiner*—Joseph Williams

(74) *Attorney, Agent, or Firm*—Christensen O'Connor Johnson Kindness PLLC

(30) **Foreign Application Priority Data**

Apr. 16, 1998 (JP) ..... 10-106801  
Jul. 24, 1998 (JP) ..... 10-210056

(57) **ABSTRACT**

(51) **Int. Cl.<sup>7</sup>** ..... **H01J 17/04**  
(52) **U.S. Cl.** ..... **313/631; 313/633; 313/375; 313/352; 313/355**  
(58) **Field of Search** ..... 313/633, 631, 313/632, 637, 638, 352, 354, 355, 356, 357

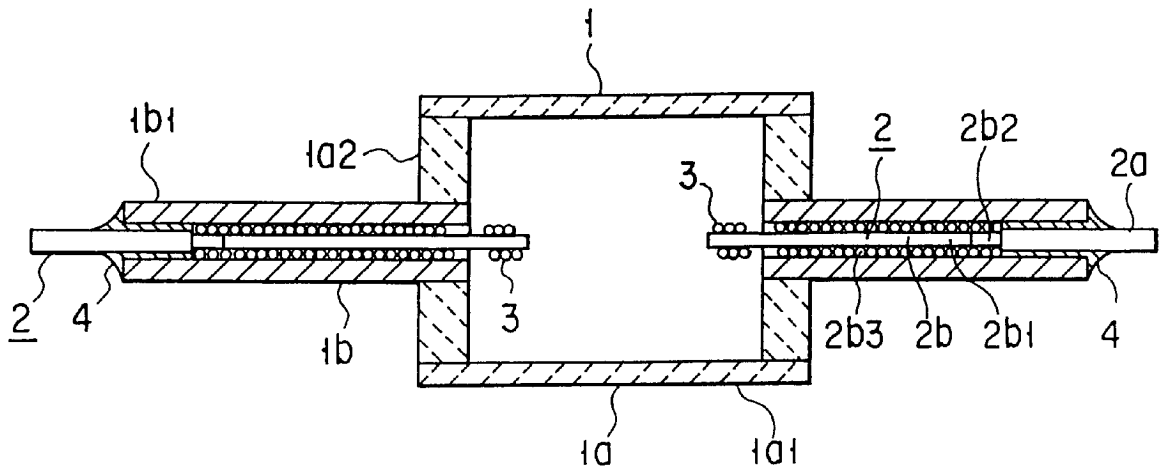
A high-pressure discharge lamp which includes a light-transmitting air-tight discharge container, an electrode formed of tungsten as a main component and fixedly sealed in the discharge container, and a discharge medium containing a halide of a light emitting metal and sealed in the discharge container. The surface of the electrode is defined as follows. That is, the average value of center line average roughness Ra of the surface, is set to 0.3 μm or less, or the average value of the center line average roughness Rz of the surface of the electrode, is set to 1.0 μm or less, or the average value of the surface area increasing rate of the surface of the electrode is set to 1.0% or less.

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**8 Claims, 8 Drawing Sheets**





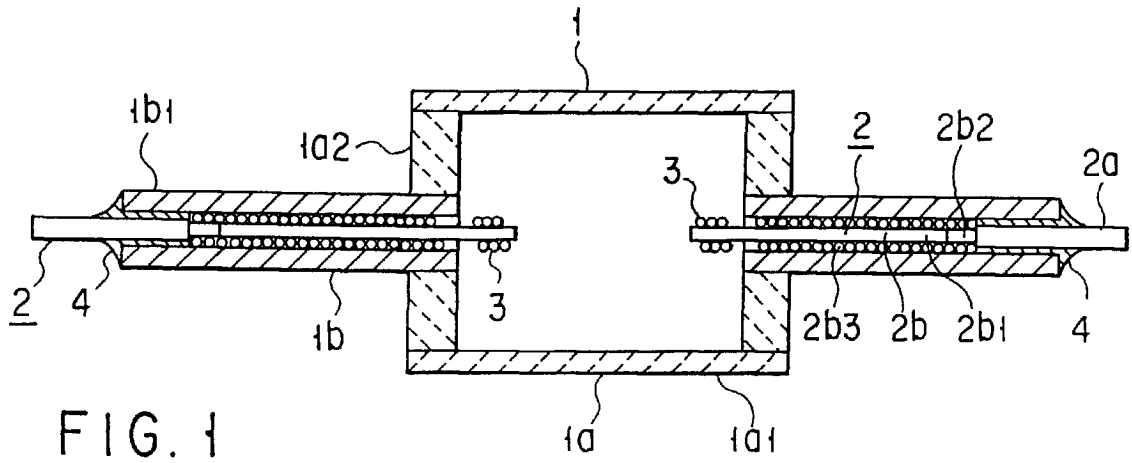


FIG. 1

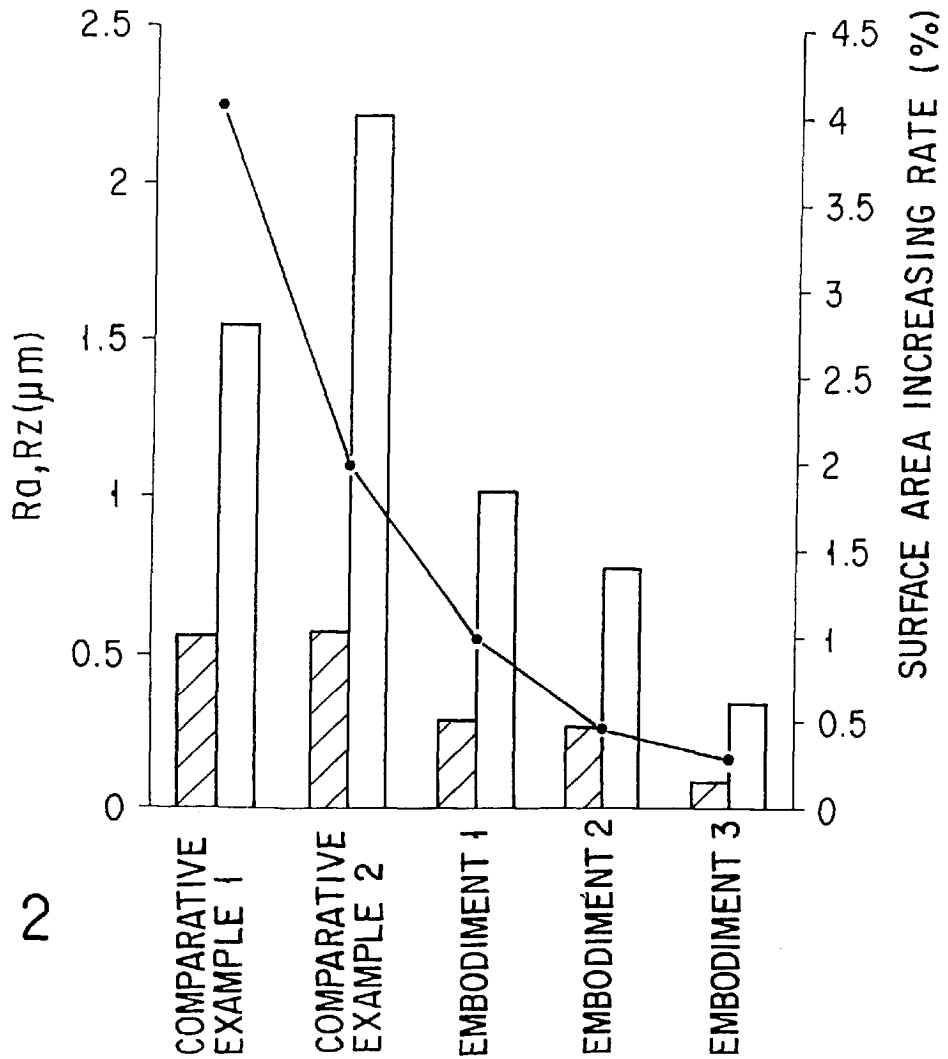
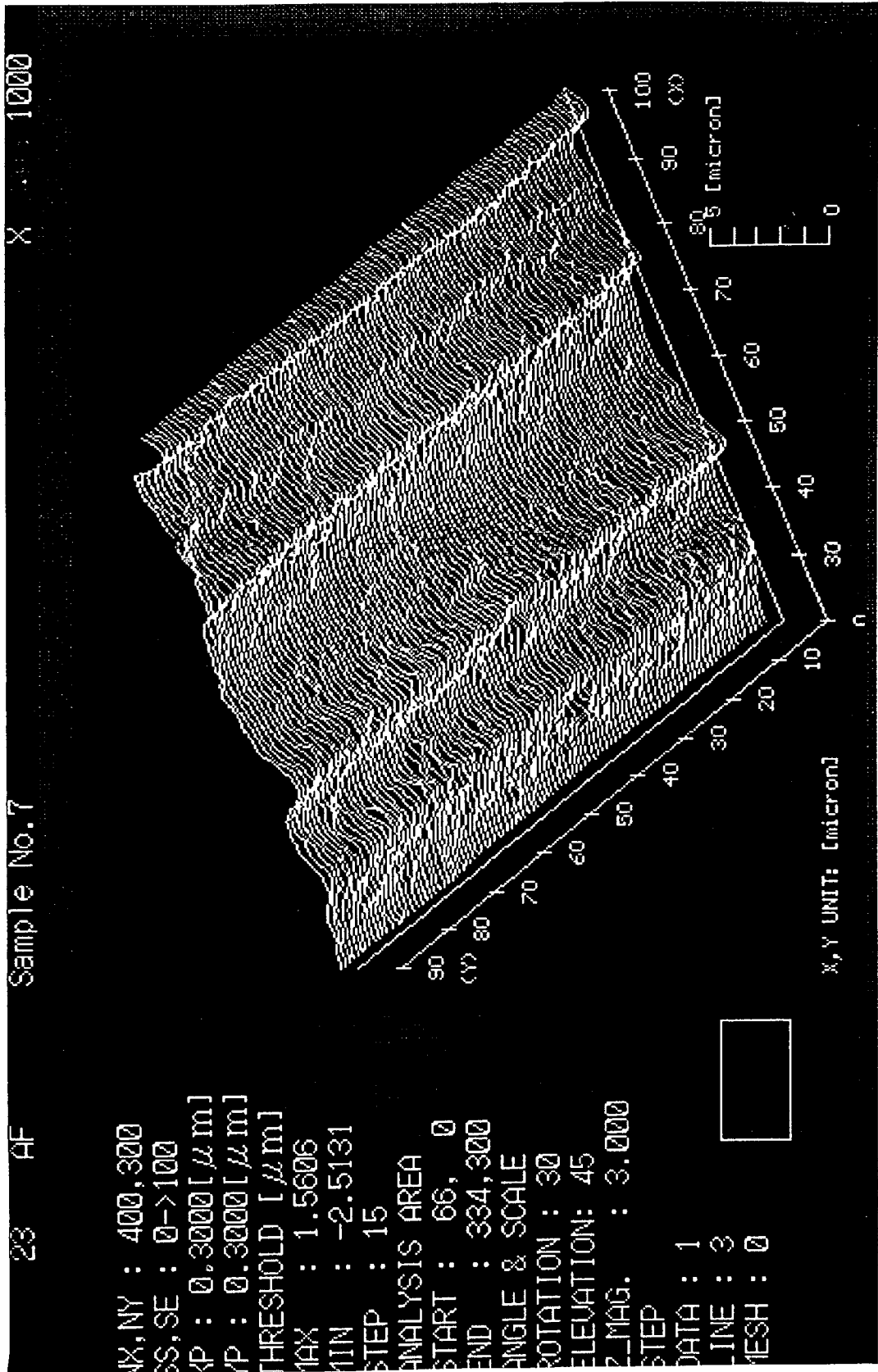


FIG. 2



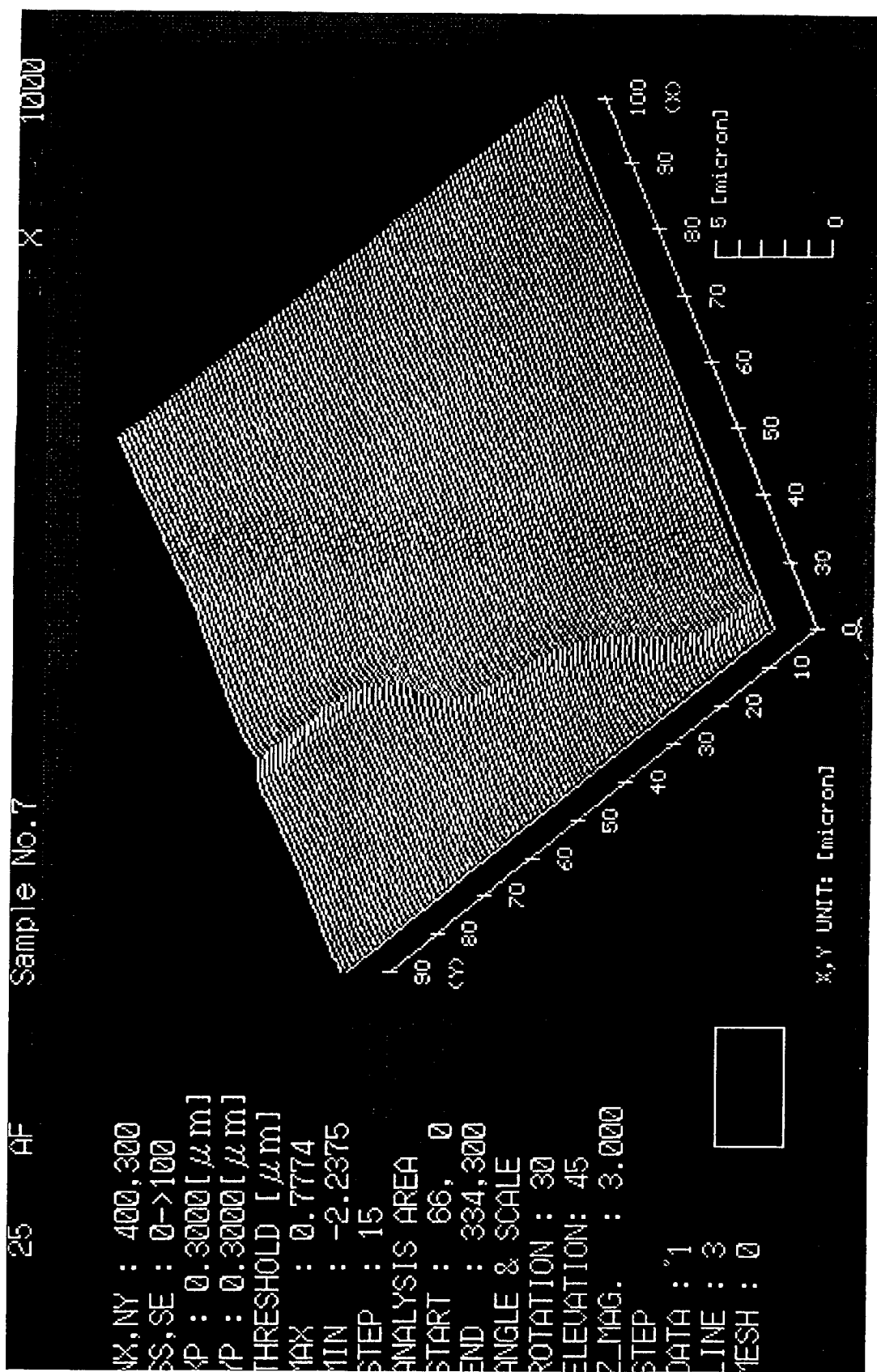


FIG. 4

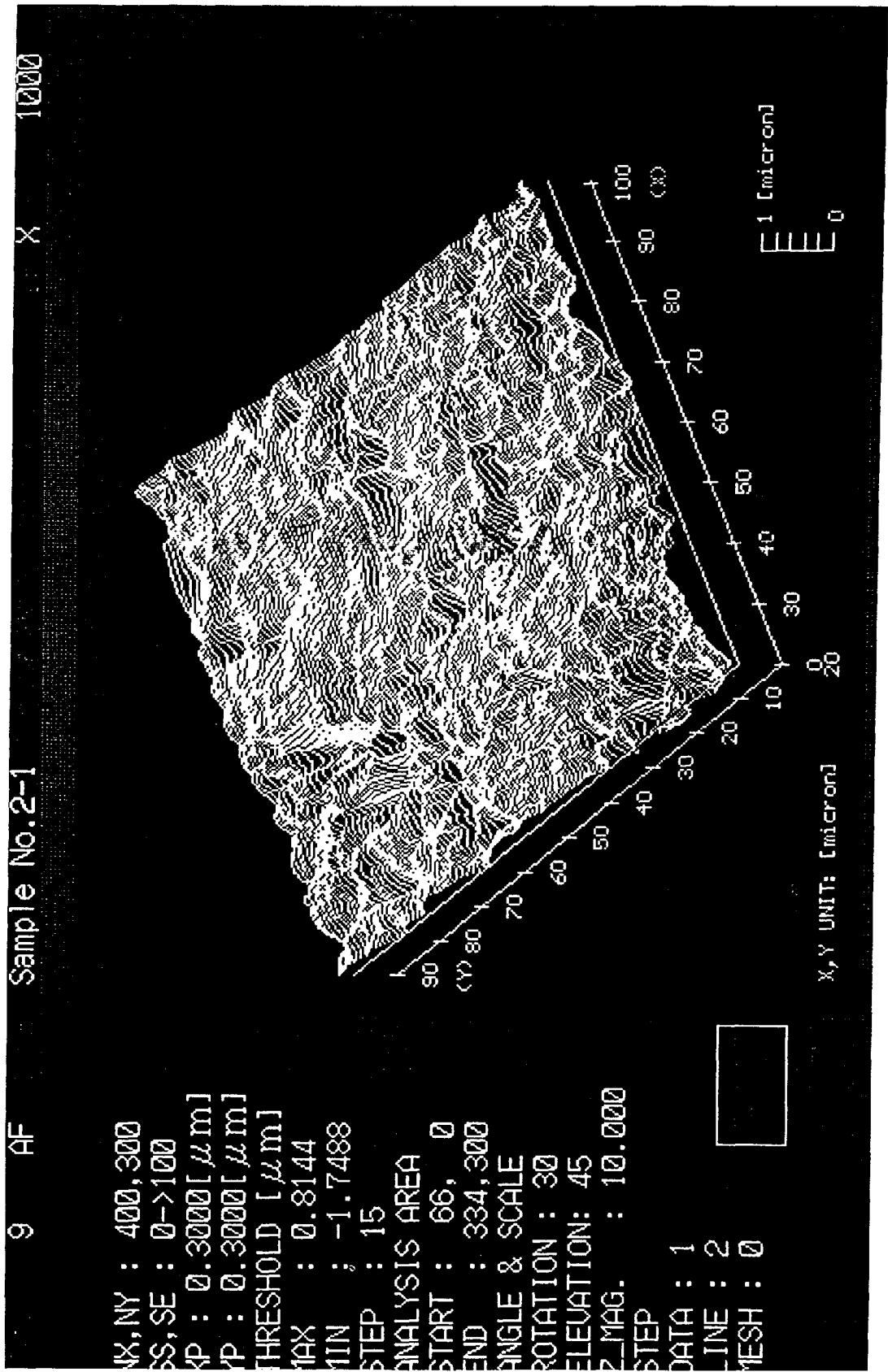


FIG.5

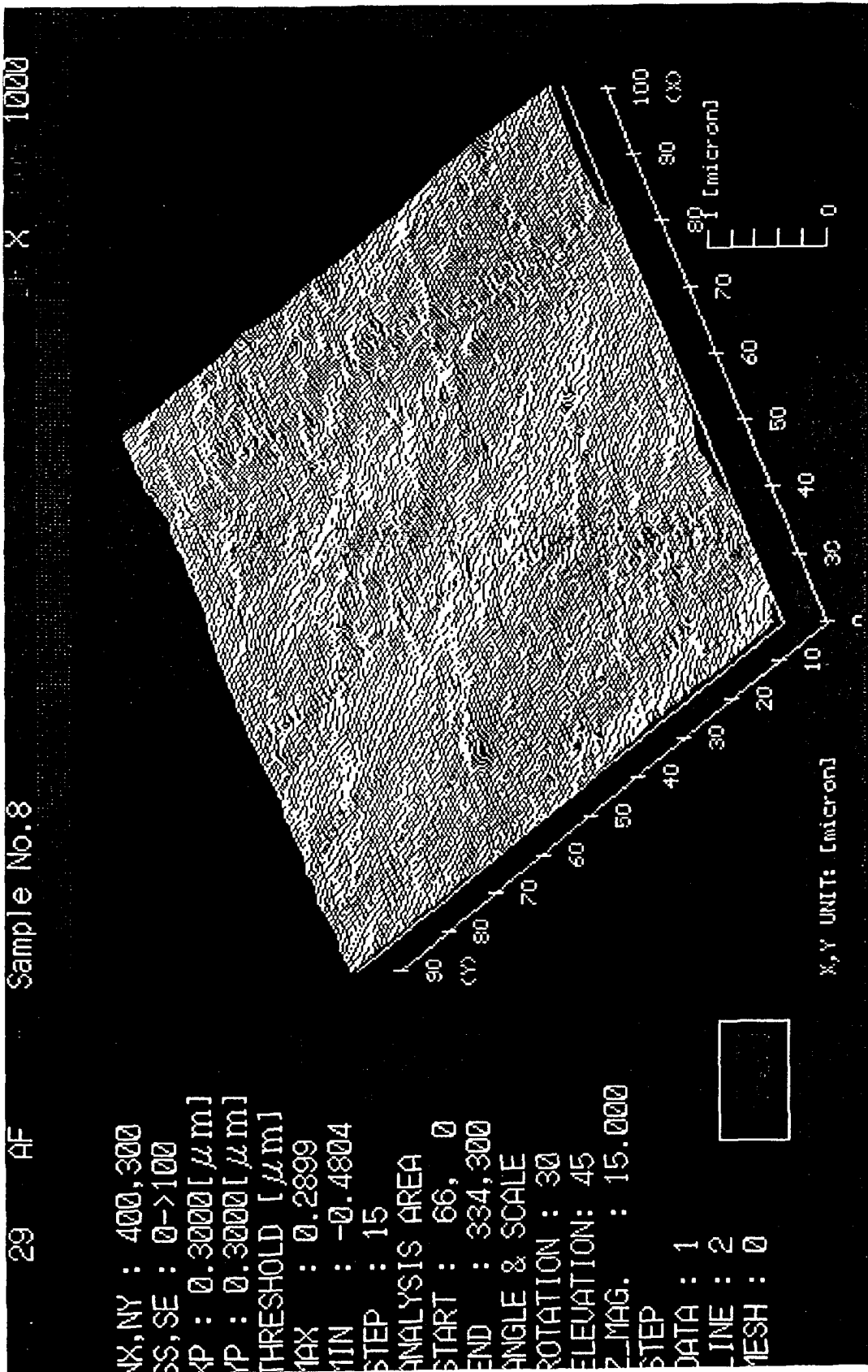


FIG.6

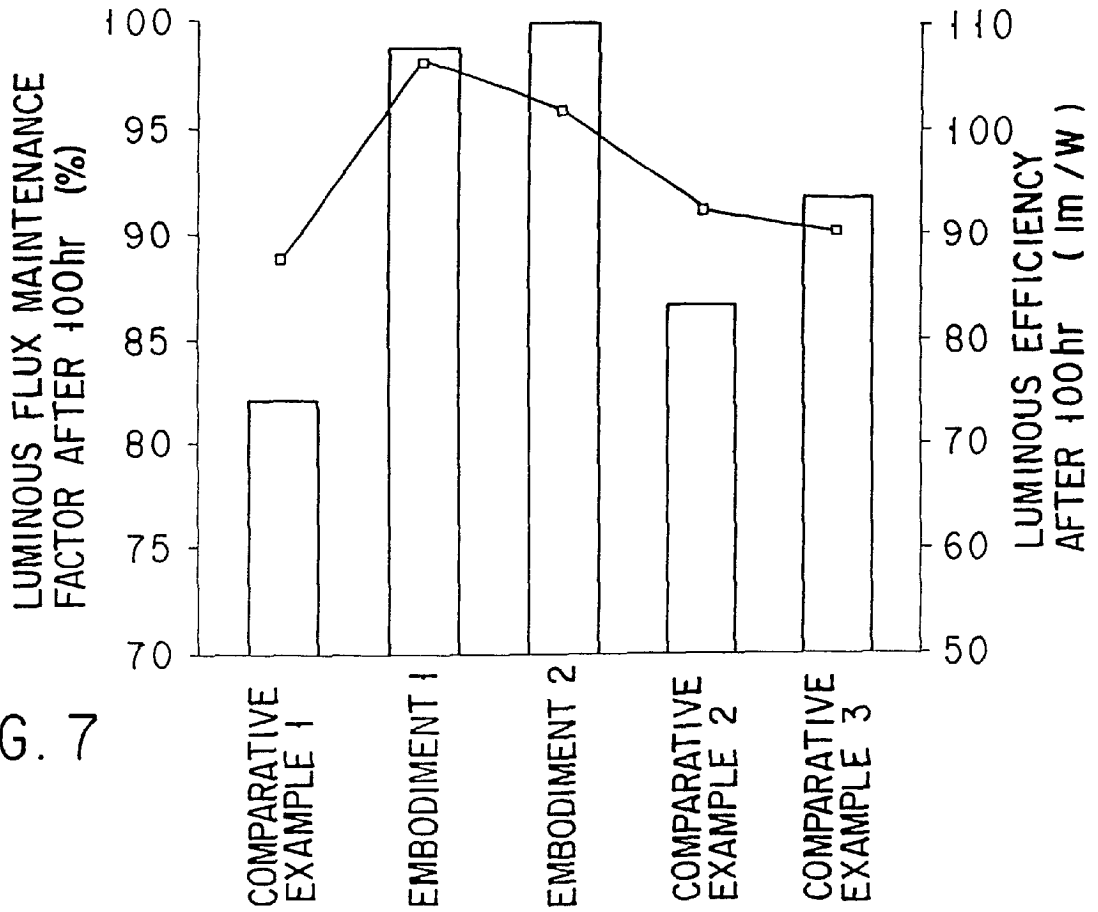


FIG. 7

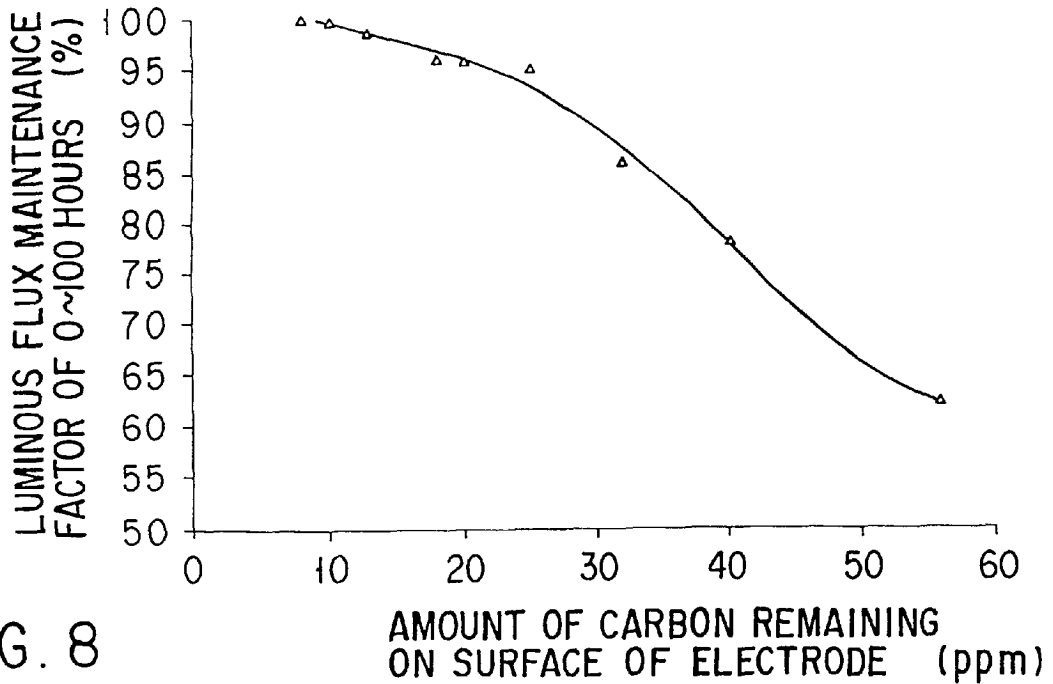


FIG. 8

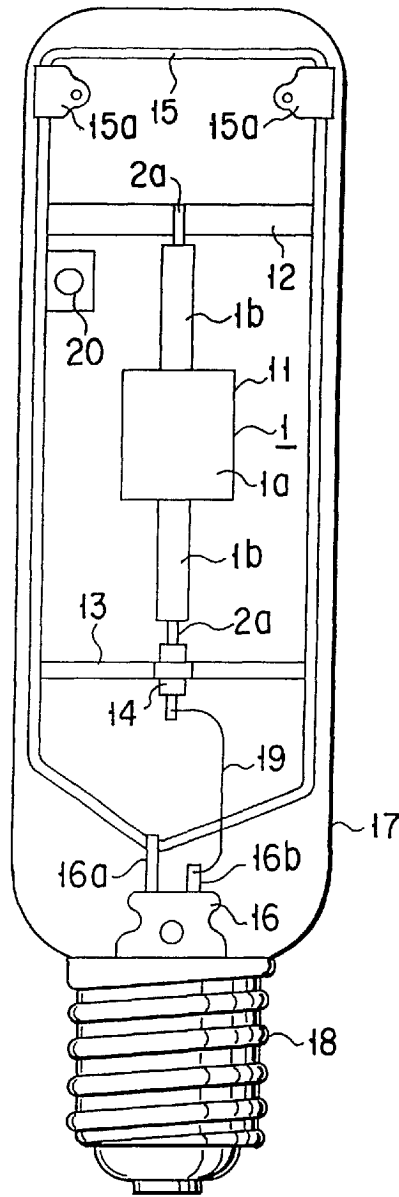


FIG. 9

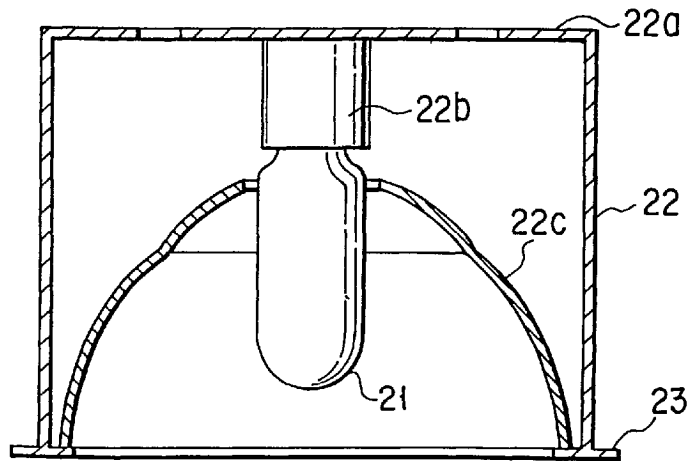


FIG. 10

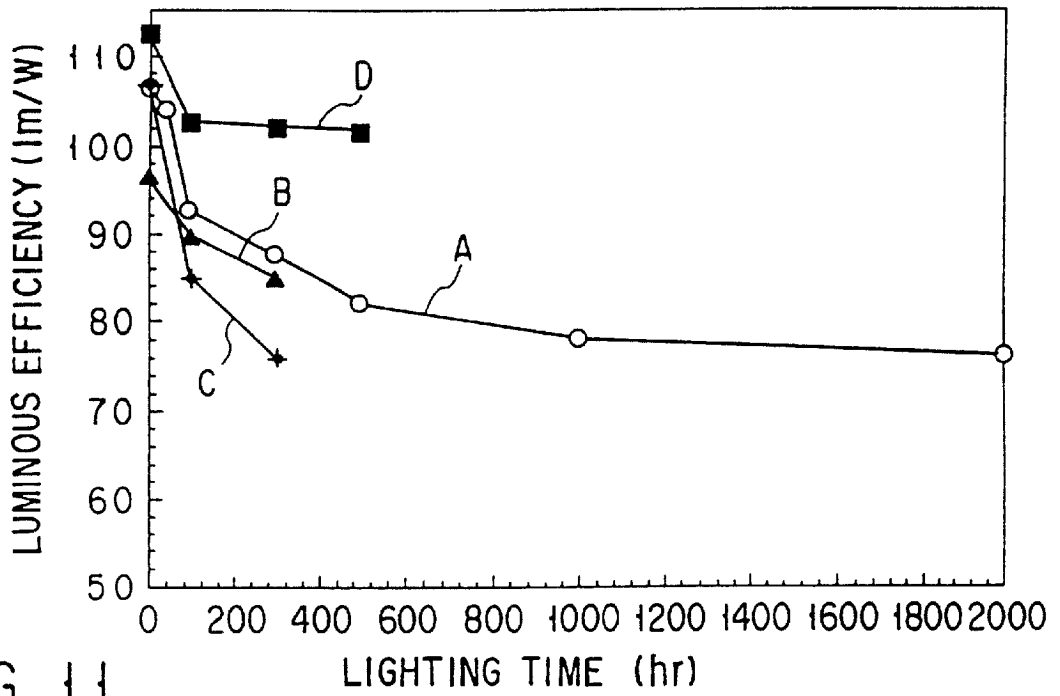


FIG. 11  
(PRIOR ART)

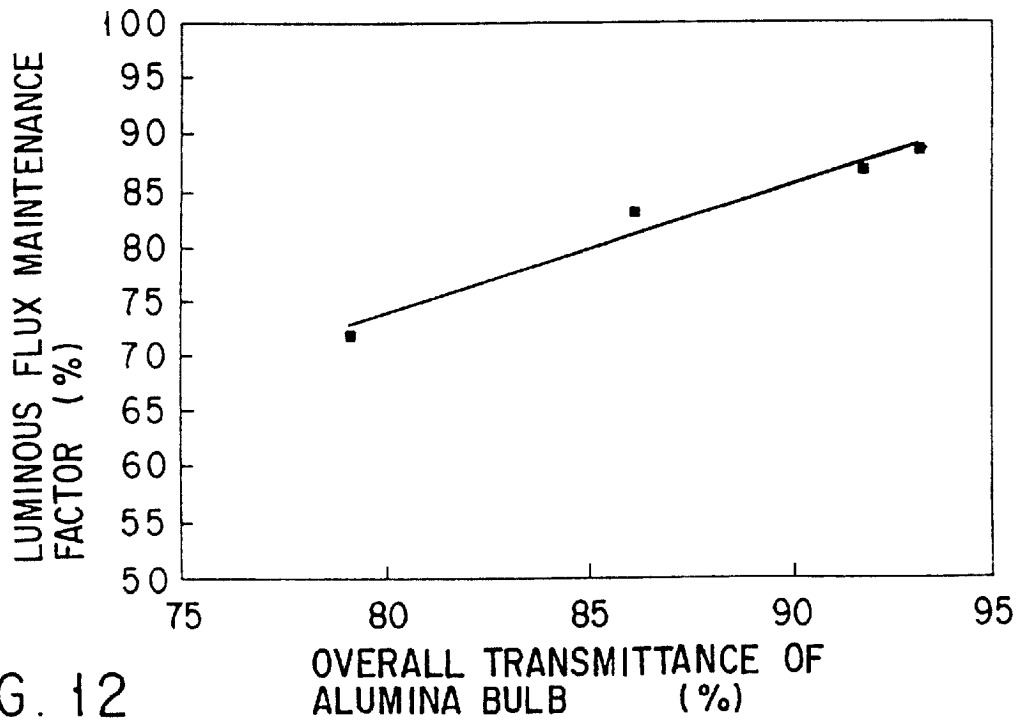


FIG. 12  
(PRIOR ART)



**HIGH-PRESSURE DISCHARGE LAMP****CROSS REFERENCE TO RELATED APPLICATIONS**

This application is a divisional of U.S. Application Ser. No. 09/458,793 filed on Dec. 10, 1999, now U.S. Pat. No. 6,249,086 issued Jun. 19, 2001, which is a continuation of International Application Ser. No. PCT/JP99/02014, filed Apr. 15, 1999 and published Oct. 28, 1999 as International Publication No. WO99/54906 which is based on Japan Patent No. 10-106801 filed Apr. 16, 1998 and Japan Patent No. 10-201056 filed Jul. 24, 1998.

**BACKGROUND OF THE INVENTION**

The present invention relates to a high-pressure discharge lamp having a light-transmitting air-tight discharge container, and an illumination device which uses the lamp.

High-pressure discharge lamps (to be called "ceramic discharge lamps" hereinafter) having discharge containers (to be called "light-transmitting ceramic discharge containers" hereinafter) made of light-transmitting ceramics are superior to conventional discharge containers made of quartz glass (to be called "quartz glass discharge containers" hereinafter) in terms of the heat resisting property and anti-corrosion property, and therefore they can achieve a high luminous efficiency and a high color rendition, as well as an excellent life duration property.

Further, light-transmitting ceramic discharge containers do not entail a phenomenon of the loss of clarity, which is caused by the reaction with light-emitting metals such as dysprosium Dy and sodium Na, and therefore they are capable of suppressing depression of luminous flux, which occurs due to the above phenomenon. Therefore, the ceramic discharge lamps are superior to high-pressure discharge lamp (to be called "quartz glass discharge lamp" hereinafter) equipped with a quartz glass discharge container in terms of the luminous flux maintenance factor.

However, while the inventors of the present invention were researching and studying a ceramic discharge lamp in order to have a higher luminous flux maintenance factor, they focused on that the luminous flux maintenance factor varies greatly within 100 hours of lighting.

FIG. 11 is a graph illustrating the luminous efficiency property with respect to the lighting time of the ceramic discharge lamp in four cases including commercially available ones and test samples.

In the figure, the abscissa axis indicates the time (hr) and the ordinate axis indicates the luminous efficiency (lm/W).

In the figure, a curve A indicates the lighting time—luminous efficiency property of the first commercially available lamp, a curve B indicates that of the second commercially available lamp, a curve C indicates that of the first test sample, and a curve D indicates that of the second test sample. All of the ceramic discharge lamps are of a 150 W-3000K type, and the light-transmitting ceramic discharge containers, electrodes, sealing structures and discharge media of these lamps are designed under substantially similar conditions.

As is clear from the figure, in all of the ceramic discharge lamps, the reduction of luminous flux is prominent within 100 hours of lighting. Further, the lowering of the luminous flux maintenance factor in this period of time becomes even several tens of %. In extreme cases, within several minutes to several hours of lighting during the aging after completion of the manufacture, the ceramic discharge container

blackens, and the luminous flux maintenance factor drastically decreases.

FIG. 12 is a graph illustrating the relationship between the entire luminous efficiency and luminous flux maintenance factor of an alumina valve which is a ceramic discharge container.

In this figure, the abscissa axis indicates the overall luminous efficiency (%) of the alumina valve and the ordinate axis indicates the luminous flux maintenance factor (%).

Further, in the figure, the overall luminous transmittance of the alumina valve of the ceramic discharge lamp and the change in the luminous flux maintaining factor until 100 hours of lighting are plotted.

As is clear from the figure, there is a clear correlation between the overall transmittance and the luminous flux maintenance factor, and the decrease in the luminous flux maintenance factor is caused by the blackening of the ceramic discharge container.

Under these circumstances, the inventors of the present invention analyzed the substance which causes the blackening, and discovered that the main component was carbon. In other words, as carbon precipitates on the inner surface of the ceramic discharge container, the blackening occurs.

Next, the source of carbon was investigated, and it was found that the sources were structural members such as electrodes, the ceramic discharge container and ceramics sealing compounds, and of these, carbon remaining on the electrodes was the main factor.

Further, a research was conducted to find out if the above-described blackening was a phenomenon unique to the ceramic discharge lamp, and it was found as a result that essentially the same phenomenon occurs in the quartz glass discharge container. However, even with the same electrode, and under the same conditions, the blackening is more prominent in the ceramic discharge container as compared to the quartz glass discharge container.

Furthermore, it was found as the results of the research and studies that the concentration of the impurities including carbon remaining on the surface of the electrode, and the like, is significantly related to the roughness of the surface of the electrode. More specifically, in the electrode of a high-pressure discharge lamp, containing tungsten as the main component, a wire material formed to have a predetermined width by the wire drawing method is used in general cases. During the drawing, a type of cut, which is called dies mark, is created, and a great amount of lubricant and polishing materials such as carbon and the like, remain in the mark of the cut.

Usually, a tungsten wire material obtained by the wire drawing is subjected to the high-temperature hydrogen process and the vacuum heat process, further, if necessary, a chemical polishing process. However, in practical cases, whether or not an irregularity on the surface and impurities created due to these processes are sufficiently eliminated from the surface, is not examined so intensely.

If carbon remains on the surface of the electrode to form WC or the like, the vapor pressure increases as compared to the case of pure tungsten, and the melting point decreases. Therefore, the amount of substance of the electrode scattered while lighting markedly increases.

In some cases, a mechanically polished wire which has been subjected to a so-called barrel polishing after forming an electrode by grinding is used; however alumina is used as

the polisher, and alumina easily attaches to and remains on the surface of the tungsten wire material.

Alumina attached to the electrode reacts with quartz at high temperature in the quartz glass discharge container while lighting, to create alumina silicate, thus causing whitening in the discharge container. Further, alumina reacts with tungsten on the surface of the electrode while lighting, to form tungsten aluminate. Once tungsten aluminate is formed, the vapor pressure increases more as compared to the case of pure tungsten, and the melting point decreases. Therefore, the amount of the substance for the electrode, scattered while lighting, markedly increases. Further, if there are innumerable recesses and projections in the surface of the electrode after the completion of the above-described process, electron emission characteristic from the surface of the electrode and effective work function vary from a side to side on the surface of the electrode, and therefore it is considered that it causes the blinking of discharge.

The inventors of the present invention have found that if the concentration of impurities such as carbon and the like, which remain on the surface of the electrode, and the recesses and projections on the surface are controlled by setting the state of the surface of the electrode to predetermined conditions, the scattering of the substance for the electrode and the blinking of discharge can be significantly improved.

In the field of the high-pressure discharge lamp, the technique for improving the decrease in the luminous flux maintenance factor and the discharge blinking phenomenon, which are caused by the decrease in the light transmittance, which are due to the blackening, whitening or the loss of clarity, is disclosed in, for example, Jpn. Pat. Appln. KOKOKU Publication No. 5-86026.

However, the above-mentioned prior art technique, although an effect can be obtained to some extent, is not an essential countermeasure to the blackening caused by remaining carbon, but rather a secondary countermeasure (after treatment). Thus, the prior art technique is not an ultimate solution. As a result, the effect and stability of the degree which can be achieved by the prior art technique are not sufficiently satisfactory.

#### BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a high-pressure discharge lamp in which impurities such as carbon and the like, which remain on the surface of the electrode, are lessened, by setting the state of the surface of the electrode to predetermined conditions, and a lighting device which uses the discharge lamp.

The present invention has been proposed based on the finding by the inventors that the rapid decrease in the luminous flux maintaining factor within 100 hours of lighting is caused by the blackening of the discharge container with carbon, and the main factor of the blackening is carbon remaining on the surface of the electrode. Thus, another object of the present invention is to provide a high-pressure discharge lamp which has an improved luminous flux maintenance factor and luminous efficiency within 100 hours of lighting, and a lighting device which uses the discharge lamp.

The first high-pressure discharge lamp of the present invention is characterized by including a light-transmitting and air-tight discharge container, an electrode made of a material whose main component is tungsten, and having a surface whose center line average roughness Ra is 0.3  $\mu\text{m}$  or less, which is sealed in the discharge container, and a

discharge medium containing a halide of a light emitting metal and sealed in the discharge container.

In the first invention and each of the other inventions, the following terms will be defined and have technical meanings as below as long as they are especially designated.

Regarding the Discharge Container:

The material which constitutes the discharge container may be either one of light-transmitting ceramics and quartz glass.

First, the light-transmitting ceramic discharge container will now be described.

The "light-transmitting ceramics" mean fire resisting materials including a monocrystal metal oxide such as sapphire, a polycrystal metal oxide such as semitransparent air-tight aluminum oxide (DGA), yttrium-aluminum-garnet (YAG) or yttrium oxide (YOX), and a polycrystal non-oxide such as aluminum nitride (AlN).

It should be noted that the "light-transmitting" property is meant to be at least such a degree that light emitted by discharge can be guided to outside as transmitting through the discharge container, and it may be either transparent or diffusion light-transmitting.

In the case of the light-transmitting ceramic discharge container, generally, a pair of end portions are formed at both ends of a swelling portion, in which discharge is made to occur, and the sealing is made at the end portions.

In the manufacture of the discharge container, the swelling portion and the end portions can be formed of light-transmitting ceramics integrally from the beginning. As an alternative method, it is possible that a swelling portion is prepared by forming a cylindrical body and a pair of end plates each having a hole at its center, which close both ends of the cylindrical body, of a ceramic material, by preliminary formation, and end portions by inserting slender tubes formed of a ceramic material or cermet material by preliminary formation, into the center holes of the end plates, and assembling them into a shape of a discharge container, followed by sintering to integrate them air-tightly.

In the sealing at the end portions of the discharge container, a sealing metal portion of an feeding conductor is mounted air-tightly via the sealing of the ceramic sealing compound, which will be described later. However, in the present invention, a ceramic sealing compound is not essential to the sealing of the light-transmitting ceramic discharge container, but any sealing will do as long as it is sealed with appropriate means.

Next, the quartz glass discharge container will now be described.

Quartz glass discharge containers have been widely used before the use of light-transmitting ceramic discharge containers started, and they are still used.

Generally a quartz glass discharge container consists of a swelling portion at center and a pair of end portions as in the case of a light-transmitting ceramic discharge container. However, quartz glass softens when heated, and melts; therefore generally, it is sealed with pinch seals at the end portions, where sealing metal foils are used. However, in the present invention, a pinch seal which uses a sealing metal foil is not essential, but any sealing will do as long as it is sealed with appropriate means.

Regarding the Electrode

First, the roughness of the surface of the electrode will now be described.

The electrode sealed in a discharge container functions to render discharge to occur in the discharge container, and the

average of the center line average roughness Ra of the surface must be limited to 0.3  $\mu\text{m}$  or less. It should be noted that, in the present invention, the "center line average roughness Ra" is defined as follows. That is, a center line is obtained from the height curve, and waveform portions located below the center line is folded up at the center line. Then, the total of the areas surrounded with respect to the center line is divided by the measured length, thus obtaining the center line average roughness. This is defined by JIS B0601; however the actual measurement is performed as follows. Also, it should be noted that the average value is that of the result of measurements carried out at multiple points of a sample within a range of 120  $\mu\text{m}$   $\times$  90  $\mu\text{m}$ .

That is, as the measuring device, "Electron Beam 3-Dimensional Roughness Analyzing Device ERA-8000 type" of Elionisk Inc. is used to photograph the surface of the electrode, which is further enlarged by 1000 times to be analyzed.

The surface of the electrode is measured as a surface of an electrode axial portion adjacent to the main portion of an electrode coil or the like, based on how easily the roughness of the surface can be measured and the degree of the influence regarding the scattering of the substance for the electrode.

The reason for limiting the roughness of the surface of the electrode as described above is that the amount of impurities attached is lessened, and therefore the scattering of the electrode substance is generally less, thus improving the luminous flux maintenance factor, and the blinking of discharge is lessened. On the other hand, when the above range exceeds, there is a tendency that the scattering amount of the substance of the electrode is increased and the rate of blinking of electrical discharge is increased.

It should be noted that in the present invention, the means for suppressing the roughness of the surface is arbitrary. For example, a desired surface roughness can be obtained by chemical polishing.

In the meantime, in the present invention, the reason why the electrode is limited to that containing tungsten as the main component is not only that tungsten is generally widely used as a material for electrodes because of its excellent heat resistance and electron radiating property, but also that in the course of manufacturing a tungsten material and electrode, impurities such as WC, W<sub>2</sub>C and tungsten aluminate are easily absorbed in the surface.

The expression "tungsten as the main component" means that tungsten is allowed to be genuine tungsten or tungsten containing sub-components. Examples of tungsten containing sub-components are so-called doped tungsten and Re-added tungsten.

Further, in the present invention, it suffices if at least one of the pair of electrode satisfies the limitation of the roughness of the surface. This is because at least one half of the effect can be obtained.

Next, the structure of the electrode will now be described.

In the present invention, the structure of the electrode is arbitrary. An appropriate type can be selected for use, from conventional electrode structures in accordance with the rated consumption power of the high-pressure discharge lamp.

The high-pressure discharge lamp of the present invention may be structured such as to be turned on by either alternating or direct current. Therefore, in the case where the lamp is operated by alternating current, the electrodes are formed to have the same structure, whereas in the case

where it is operated by direct current, the anode should be of a type having a heat radiating area larger than that of the cathode since the increase in the temperature is generally intense in the anode.

Further, the sealing and fixing of the electrode and the sealing of the discharge container will now be described.

First, the case of the light-transmitting ceramic discharge container will be explained.

That is, in the case of the light-transmitting ceramic discharge container, the electrodes are fixed and sealed via an feeding conductor, and the discharge container is sealed.

The feeding conductor is made of a sealed metal portion and an anti-halogenation material portion provided at a tip end of the sealed metal portion.

The sealed metal portion is made of a metal rod of, for example, niobium which has a thermal expansion coefficient closer to that of light-transmitting ceramics.

As the anti-halogenation material portion, a metal rod of, for example, molybdenum or tungsten, is used. Since molybdenum has a thermal expansion coefficient closer to that of niobium or ceramics than that of tungsten, a relatively short molybdenum rod is used for the section to be connected to the sealed metal portion, and a tungsten rod can be connected to the tip end of the molybdenum rod.

Further, a slender wire made of molybdenum or tungsten can be wound around the anti-halogenation portion. This coil is called capillary coil.

It should be noted that when at least the most of the anti-halogenation material is made of a tungsten rod, and a tungsten capillary coil is prepared, the difference in thermal expansion coefficient between the sealed metal portion and ceramic portion can be absorbed while reducing the scattering amount of impurities from the feeding conductor. Therefore, excellent sealing can be achieved.

Thus, an electrode is provided at the tip end of the tungsten rod. Here, it is possible that the proximal end of the electrode shaft is connected to the tip end of the tungsten rod of the anti-halogenation material portion, an electrode coil is mounted on the tip end portion of the tungsten rod, or the electrode can be formed to be integrated with the anti-halogenation material portion without being mounted.

Next, the sealed metal portion is inserted such that a part thereof is located in the end portion of the discharge container, and the ceramic sealing compound is applied to the end portion. Further, it is melted by heat so as to form a seal between the sealed metal portion and the end portion. It should be noted that the portion of the feeding conductor, which has a sealing property, is easily eroded by a halogen, and therefore it is preferable that the portion located in the end portion should be covered completely with the seal of the ceramic sealing compound.

In the ceramic discharge lamp completed by the above-described steps, a part of the sealing metal portion of the feeding conductor projects from the end portion of the discharge container to the outside, and therefore the part serves as a lead wire for applying a voltage between the electrodes via a ballast means, to start the high-pressure discharge lamp, and introducing a current for the lamp to light up.

In the meantime, a small gap called capillary is made between the end portion of the light-transmitting ceramic discharge container and the anti-halogenation portion (the electrode shaft of tungsten and/or the molybdenum rod) of the feeding conductor. The small gap is made in a space created between the anti-halogenation portion of the feeding

conductor and the inner surface of the end portion of the discharge container, having at least 5  $\mu\text{m}$ , having a size, at maximum, of  $\frac{1}{4}$  of the inner diameter of the end portion, and about 200  $\mu\text{m}$  or less. For this reason, the diameter of the anti-halogenation material portion of the feeding conductor which pierces through the end portion is set at least  $\frac{1}{2}$  of the inner diameter of the end portion.

Alternatively, the small gap can be formed between the outer circumferential surface of the coil of the anti-halogenation material portion and the inner surface of the end portion. The anti-halogenation material portion of the feeding conductor is made of a tungsten or molybdenum rod and a coil wound around the rod.

Further, while operating the ceramic discharge lamp, an excessive halide material in the liquid state enters the small gap to form the coolest portion; however by setting the width of the gap appropriately, a desired coolest temperature can be achieved.

The seal of the ceramic sealing compound has a heat resistance sufficient to withstand a high temperature of the high-pressure discharge lamp while it is on, and the thermal expansion coefficient is adjusted to an intermediate between that of the lead wire and that of the light-transmitting ceramic discharge container. For example,  $\text{Al}_2\text{O}_3\text{—SiO}_2\text{—Dy}_2\text{O}_3$ -based or  $\text{Al}_2\text{O}_3\text{—SiO}_2\text{—Nd}_2\text{O}_3$ -based ceramic sealing compound can be used.

Next, the sealing of the electrodes and discharge container in the case of the quartz glass discharge container will now be described.

Electrode shafts and outside lead wire are welded to both ends of a sealed metal foil made of molybdenum, to prepare an electrode assembly body, and it is inserted to the end portion of the glass discharge container from the electrode such that the sealed metal foil is situated at the end portion. Then, the end portion is softened by heat, and pinched over the sealing metal foil with use of a mold. Thus, the sealed metal foil and the pinched quartz glass are air-tightly sealed. The electrode shafts are softened, and loosely supported by the end portion whose diameter has been reduced.

#### Regarding the Discharge Medium

A discharge medium consists of a halide of a light emitting metal as an essential material, and, if necessary, others such as noble gas and a buffer medium which set the lamp voltage to a predetermined value.

As a light-emitting metal, an arbitrary and desired one can be selected for use, and for example, sodium Na, scandium Sc and a rare earth metal may be used solely or in a mixture of a plurality of types. It should be noted that as a halogen, iodine I, bromine Br, chlorine Cl, or fluorine F can be used.

As the noble gas, argon Ar, krypton Kr or xenon Xe can be used mainly for starting. Further, for the ceramic discharge container, neon can be used.

As the buffer medium, mercury or, in place of mercury, a halide of a metal which does not emit light in a visible range or emits relatively less light, and has a vapor pressure relatively high such as aluminum Al or iron Fe can be used solely or a plurality of such halides can be used.

#### Regarding the Other Structures:

The high-pressure discharge lamp of the present invention may be of a short arc type or a long arc type.

The short-arc type is a so-called electrode stabilization type, which stabilizes an arc discharge with the electrodes by reducing the inter-electrode distance set between a pair of electrodes in the discharge container. The short-arc type high-pressure discharge lamp is used for, for example, a liquid crystal projector, and a front light of an automobile.

On the other hand, the long-arc type is a so-called tube wall stabilization type, in which the arc discharge is stabilized in the inner surface of the discharge container, by increasing the inter-electrode distance set between a pair of electrodes in the discharge container, to be larger than the inner diameter of the swelling portion of the discharge container tube section. The long-arc type high-pressure discharge lamp is widely used in general illumination lights.

#### Regarding the Effect of the Present Invention:

In the high-pressure discharge lamp according to the first aspect of the present invention, with the regulation of the average value of the center line average roughness Ra of the surface of the electrode set to 0.3  $\mu\text{m}$  or less, impurities which include mainly carbon and the like, created by marks including a dies mark made during the wire drawing of tungsten or from the lubricant and polisher remaining as they attach to the surface, are eliminated substantially completely, and therefore the decrease in the transmittance, due to the blackening, whitening, or the loss clarity of the discharge container, is markedly lessened. As a result, the luminous flux maintenance factor is improved.

Further, the irregularity of the surface of the electrode is reduced, and therefore the blinking phenomenon of the discharge is essentially improved.

In the high-pressure discharge lamp according to the second aspect of the present invention, the electrode has an average value of the center line average roughness Ra of the surface, that is 0.1  $\mu\text{m}$  or less.

In the present invention, the average value of the center line average roughness Ra of the surface of the electrode is limited further strictly as described above. Therefore, marks such as dies marks created during wire drawing, impurities such as lubricant and polisher remaining as being attached in the marks, or impurities including a polisher, attached due to mechanical polishing such as barrel polishing carried out after grinding, are substantially completely removed. In this manner, the decrease in the transmittance, caused by the blackening, whitening or the loss of clarity of the discharge container, can be significantly lessened. Therefore, the luminous flux maintenance factor is further improved. Further, since the irregularity on the surface of the electrode is further lessened, the blinking of the discharge can be significantly improved.

The high-pressure discharge lamp according to the third aspect of the present invention, comprises: a light-transmitting air-tight discharge container; electrodes having an average value of ten-point average roughness Rz on the surface, of 1  $\mu\text{m}$  or less, made of tungsten as a main component and sealed in the discharge container; and a discharge medium containing a halide of a light-emitting metal and sealed in the discharge container.

In the present invention, the roughness of the surface of the electrode is limited with the average value of the ten-point average roughness Rz on the surface of the electrode. Further, as the average value of the ten-point average roughness Rz is limited to a predetermined range, marks including a dies mark made during drawing of wire, and impurities remaining as they are attached to the marks, are eliminated substantially completely, and therefore the decrease in the transmittance, due to the blackening, whitening, or the loss of clarity of the discharge container, is markedly lessened. As a result, the luminous flux maintenance factor is improved.

Further, since the irregularity of the surface of the electrode becomes less, the discharge blinking phenomenon is essentially improved.

By contrast, when exceeding the above-described range, there is a tendency that the amount of the electrode material scattered is increased, and the blinking of discharge is increased.

It should be noted that the “ten-point average roughness Rz” is a value obtained by taking the difference between the average value of the first to fifth highest peaks of the planes in parallel with the average line within a designated area, and the average of the first to fifth deepest troughs. The “ten-point average roughness Rz” is defined in JIS B0601. Further, the average value is similar to the contents described in connection with the high-pressure discharge lamp of the first aspect. The measurement thereof is similar to the contents described in connection with the high-pressure discharge lamp according to the first aspect.

In the present invention, the average value of the ten-point average roughness Rz is not necessarily correlated to the average value of the center line average roughness Ra.

The high-pressure discharge lamp according to the fourth aspect of the present invention, is based on the third high-pressure discharge lamp, further to have a feature that the electrode has an average value of the ten-point average roughness Rz of the surface, that is 0.3  $\mu\text{m}$  or less.

In the present invention, the average value of the ten-point average roughness Rz of the surface of the electrode is limited further strictly as described above. Therefore, marks such as dies marks created during wire drawing, impurities such as lubricant and polisher remaining as being attached in the marks, or impurities including a polisher, attached due to mechanical polishing such as barrel polishing carried out after grinding, are substantially completely removed. In this manner, the decrease in the transmittance, caused by the blackening, whitening or the loss of clarity of the discharge container, can be significantly lessened. Therefore, the luminous flux maintenance factor is further improved. Further, since the irregularity on the surface of the electrode is further lessened, the blinking of the discharge can be significantly improved.

The high-pressure discharge lamp according to the fifth aspect of the present invention, comprises: a light-transmitting air-tight discharge container; electrodes having an average value of surface area increasing rate on the surface, of 1% or less, made of tungsten as a main component and sealed in the discharge container; and a discharge medium sealed in the discharge container.

In the present invention, the roughness of the surface of the electrode is limited with the average value of the “surface area increasing rate” on the surface of the electrode. Further, as the average value of the surface area increasing rate is limited to 1% or less, marks including a dies mark made during drawing of wire, and impurities such as lubricant and polisher, remaining as they are attached to the marks, are eliminated substantially completely, and therefore the decrease in the transmittance, due to the blackening, whitening, or the loss of clarity of the discharge container, is markedly lessened. As a result, the luminous flux maintenance factor is improved.

Further, since the irregularity of the surface of the electrode becomes less, the discharge blinking phenomenon is essentially improved.

By contrast, when exceeding the above-described range, there is a tendency that the amount of the electrode material scattered is increased, and the blinking of discharge is increased.

It should be noted that the “surface area increasing rate” used in the present invention is meant to be a value obtained

by dividing the surface area of a sample, obtained by measurement, with the area of the measured range, length $\times$ width. The measurement thereof is similar to the contents described in connection with the high-pressure discharge lamp according to the first aspect. Further, the average value is similar to the contents described in connection with the high-pressure discharge lamp of the first aspect.

The sixth high-pressure discharge lamp of the present invention is based on the fifth high-pressure discharge lamp, and is characterized in that the surface area increasing rate of the surface of the electrode is 0.6% or less.

In the present invention, the average value of the surface area increasing rate of the surface of the electrode is limited further strictly as described above. Therefore, marks such as dies marks created during wire drawing, impurities such as lubricant and polisher remaining as being attached in the marks, or impurities including a polisher, attached due to mechanical polishing such as barrel polishing carried out after grinding, are substantially completely removed. In this manner, the decrease in the transmittance, caused by the blackening, whitening or the loss of clarity of the discharge container, can be significantly lessened. Therefore, the luminous flux maintenance factor is further improved.

Further, since the irregularity on the surface of the electrode is further lessened, the blinking of the discharge can be significantly improved.

The high-pressure discharge lamp according to the seventh aspect of the present invention is based on the high-pressure discharge lamp according to the first, third, fifth or sixth aspect, and is characterized in that the electrode has an average value of the center line average roughness Ra of the surface, of 0.3  $\mu\text{m}$  or less and an average value of the ten-point average roughness Rz of the surface, of 1  $\mu\text{m}$  or less.

In the present invention, the roughness of the surface of the electrode is limited with the average value of the center line average roughness Ra and the average value of the ten-point average roughness Rz. Further, when they are limited as described above, a more excellent result can be obtained regarding the luminous flux maintenance factor and the blinking of discharge, than in the case where each of them is used solely.

The high-pressure discharge lamp according to the eighth aspect of the present invention is based on the high-pressure discharge lamp according to the first, third, fourth or fifth aspect, and is characterized in that the electrode has an average value of the center line average roughness Ra of the surface, of 0.3  $\mu\text{m}$  or less and an average value of the surface area increasing rate, of 1% or less.

In the present invention, the roughness of the surface of the electrode is limited with the average value of the center line average roughness Ra and the average value of the surface area increasing rate. Further, when they are limited as described above, a more excellent result can be obtained regarding the luminous flux maintenance factor and the blinking of discharge, than in the case where each of them is used solely.

The high-pressure discharge lamp according to the ninth aspect of the present invention is based on the high-pressure discharge lamp according to one of the first to third, and fifth to eighth aspect, and is characterized in that the electrode has an average value of the center line average roughness Ra of the surface, of 0.1  $\mu\text{m}$  or less and an average value of the ten-point average roughness Rz of the surface, of 0.4  $\mu\text{m}$  or less.

In the present invention, the roughness of the surface of the electrode is limited further strictly with the average value



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Wada et al.

(10) **Patent No.:** US 6,897,613 B2  
(45) **Date of Patent:** May 24, 2005

(54) **DISCHARGE LAMP, LIGHT SOURCE AND PROJECTING DISPLAY UNIT**

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(22) Filed: **Feb. 14, 2003**

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**(30) Foreign Application Priority Data**

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Dec. 10, 1998 (JP) ..... 10-351047

(51) **Int. Cl.<sup>7</sup>** ..... **H01J 61/073**

(52) **U.S. Cl.** ..... **313/631; 313/634; 313/25; 313/573; 313/113; 313/332; 313/46; 313/620**

(58) **Field of Search** ..... 313/631, 634, 313/643, 25, 570, 573, 113, 332, 491, 574, 620, 46, 39; 362/296, 307, 310, 341

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**(57) ABSTRACT**

A discharge lamp of the present invention, which has an starting property, an arc stability and a service life which are improved even if the lamp produces a short arc. The discharge lamp includes a light emitting bulb, sealing members disposed on both sides of the light emitting bulb, metal foils sealed in the sealing members, a pair of electrodes which are connected to the metal foils and have large-diameter portions formed on tips, coils disposed at the rear of the large-diameter portions of the electrodes, external conductors, and a discharge medium enclosed in the light emitting bulb.

**17 Claims, 18 Drawing Sheets**

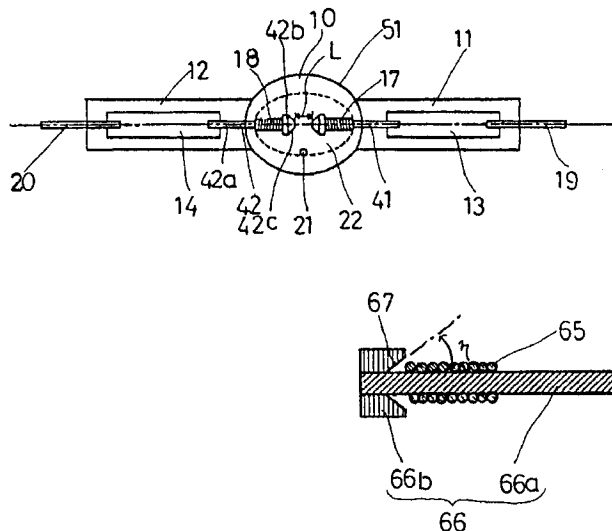


FIG. 1a

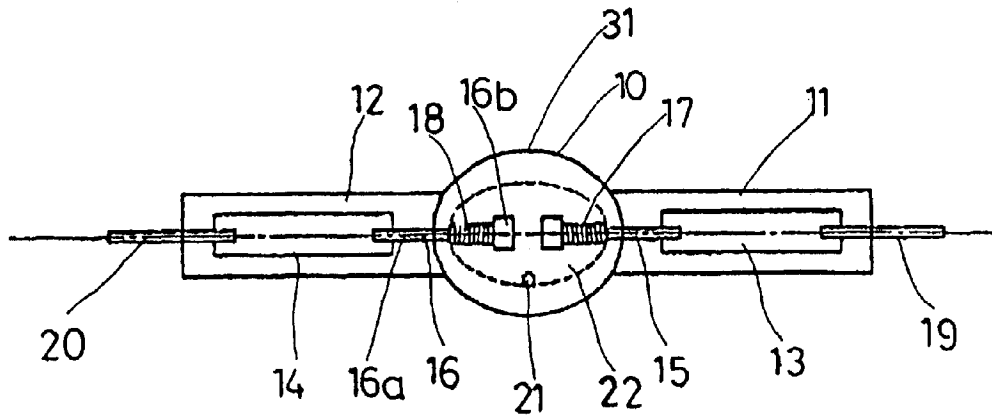


FIG. 1b

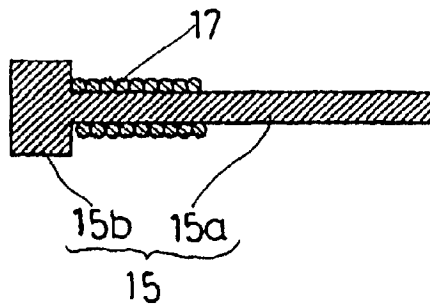


FIG. 2a

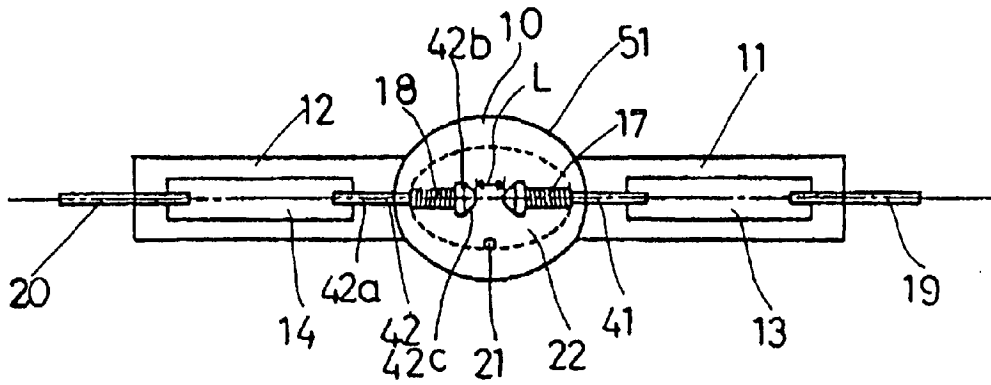


FIG. 2b

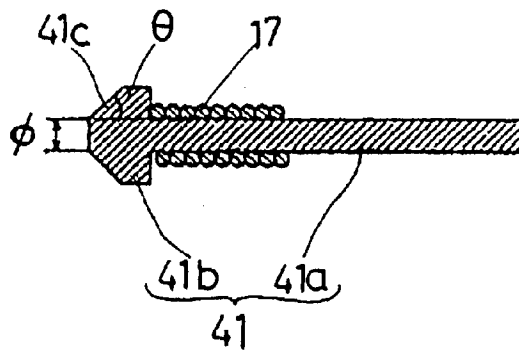




FIG. 3

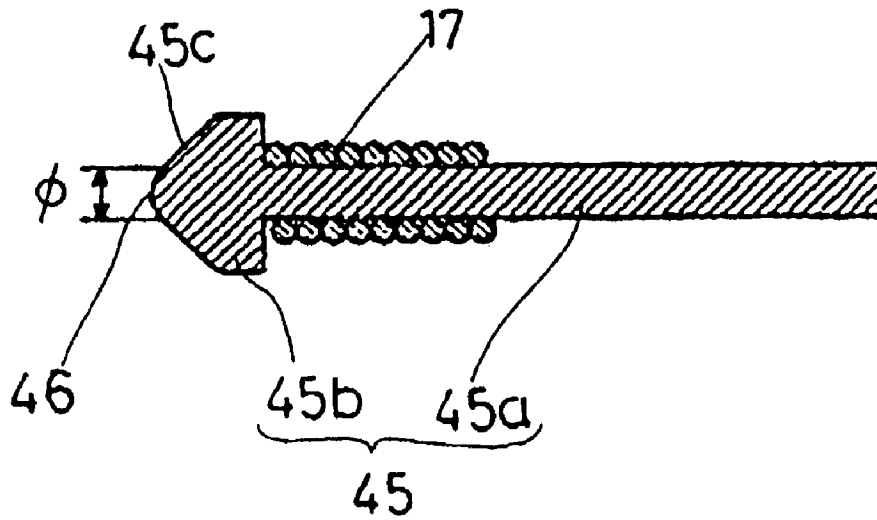


FIG. 4a

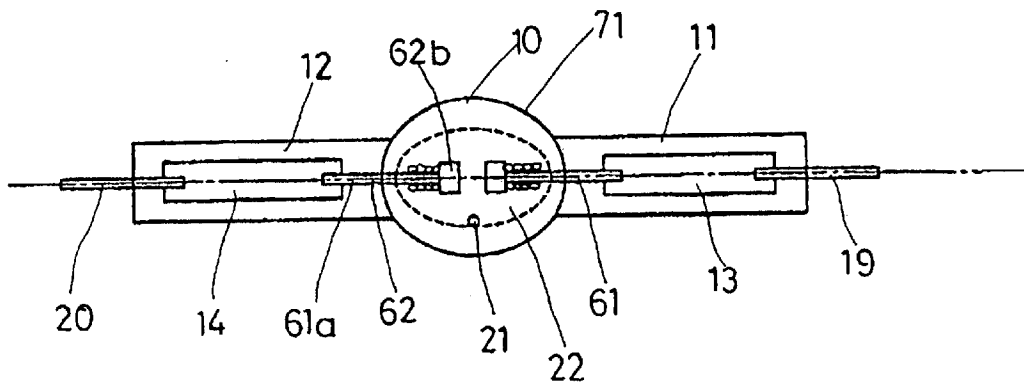


FIG. 4b

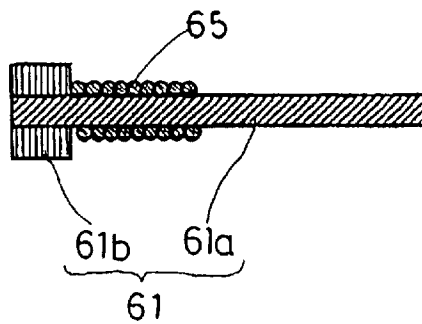


FIG. 5

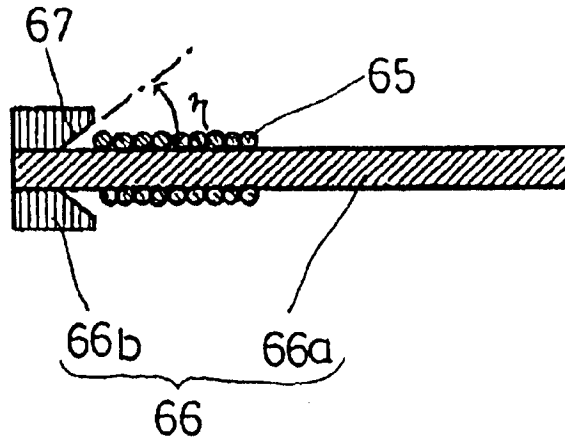


FIG. 6

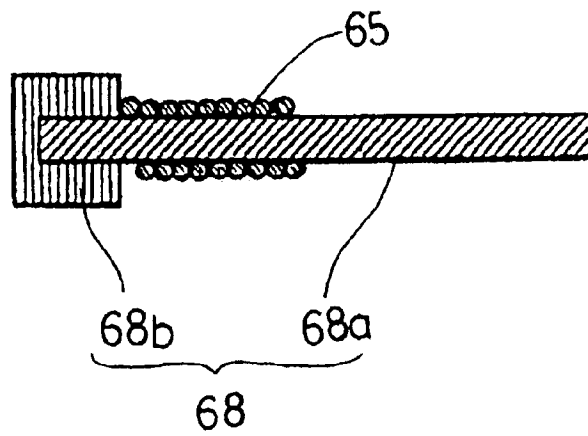


FIG. 7a

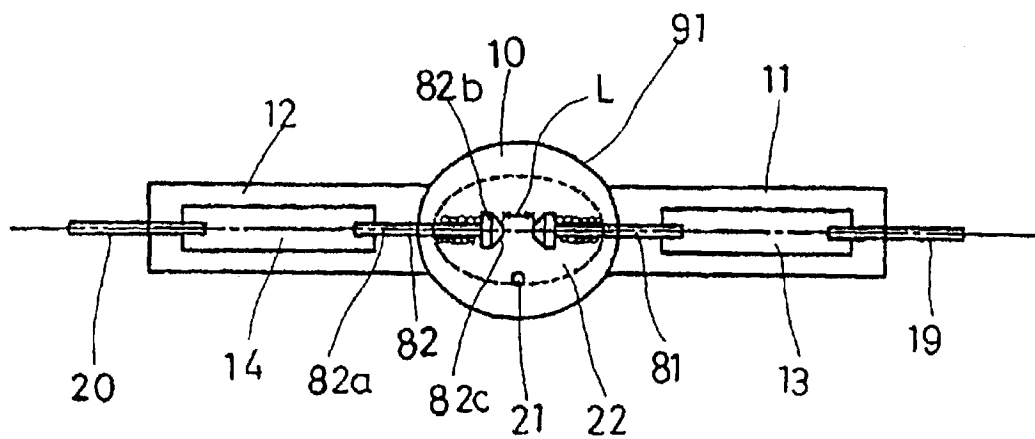


FIG. 7b

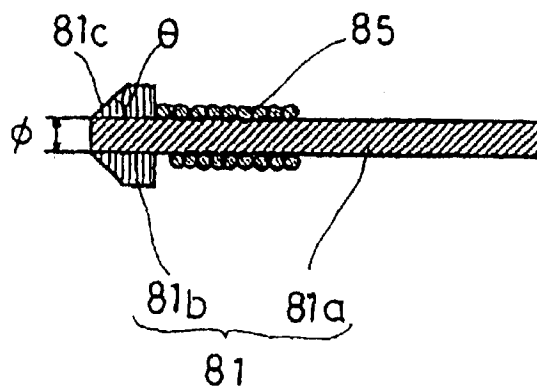


FIG. 8a

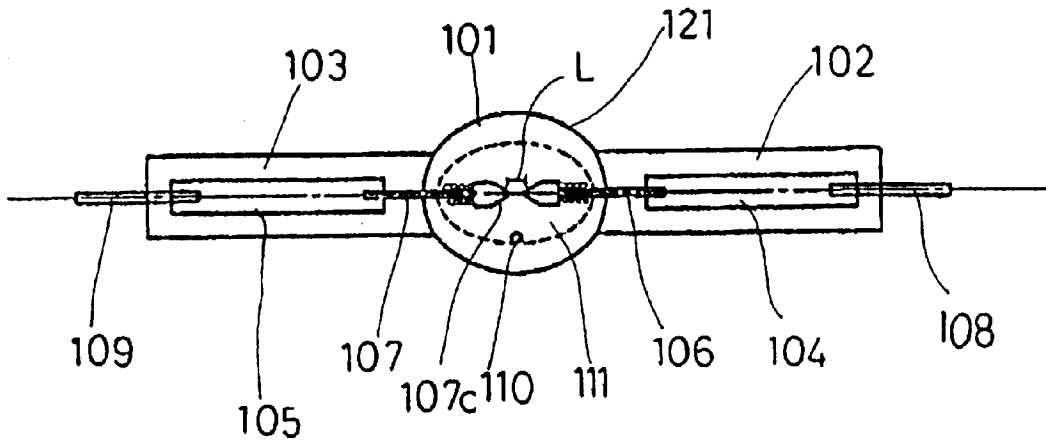


FIG. 8b

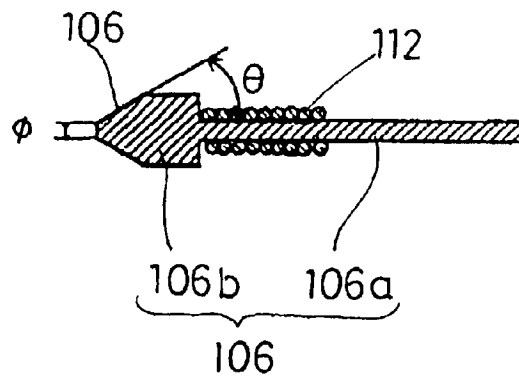


FIG. 9

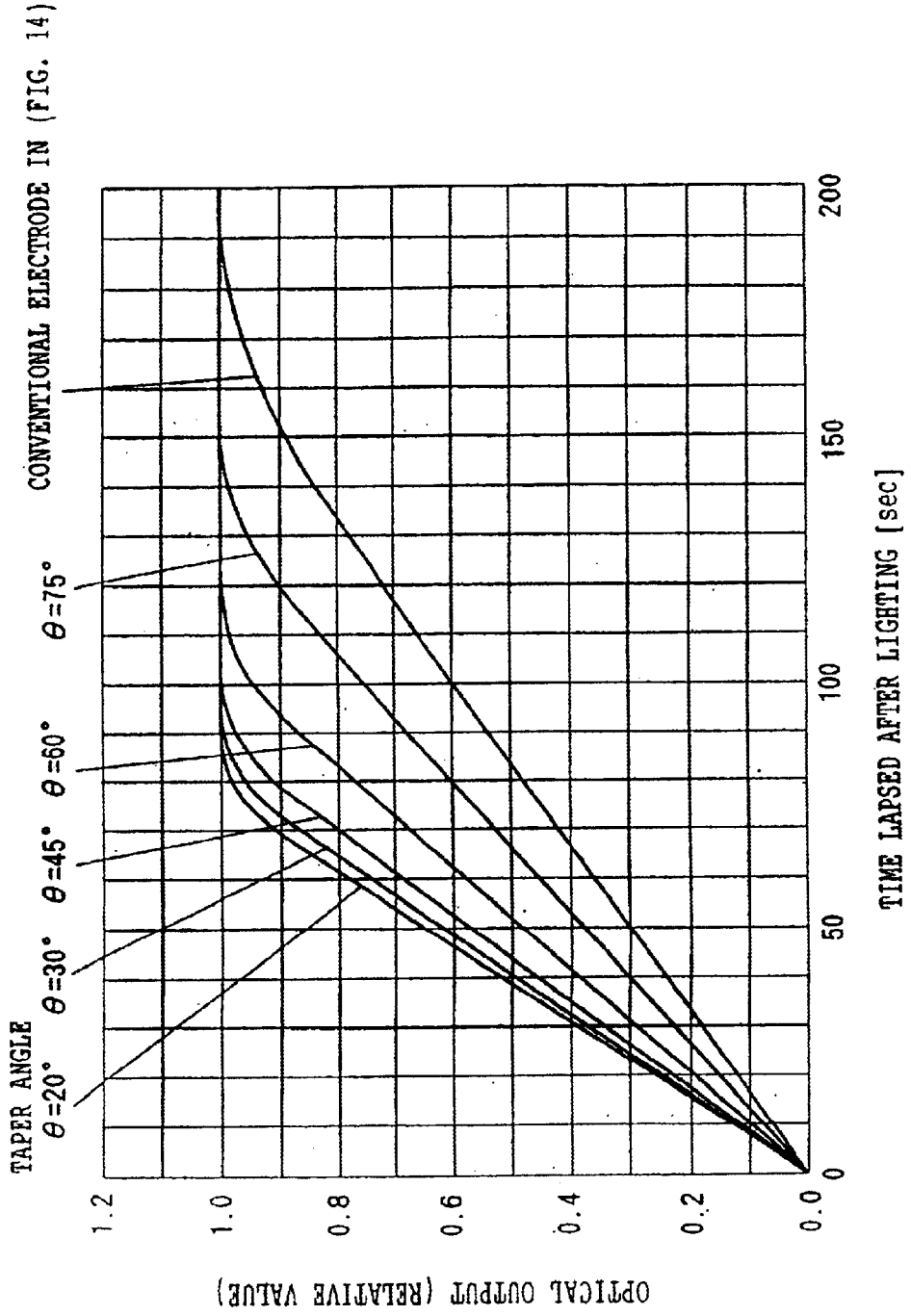
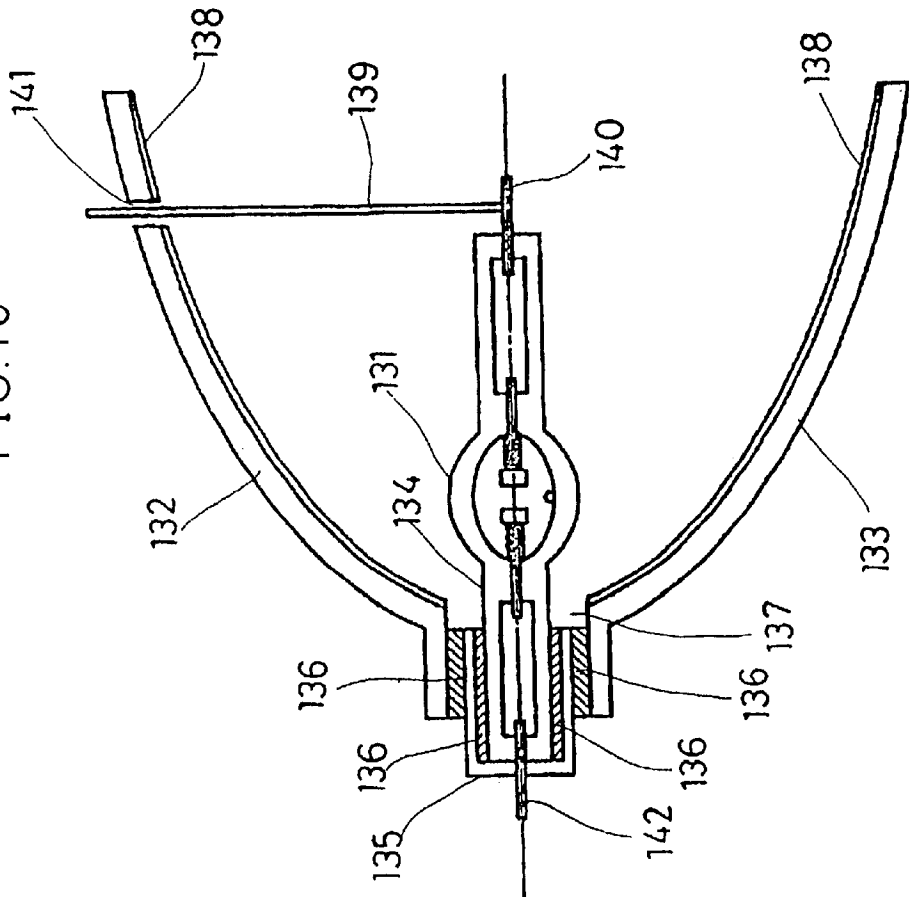
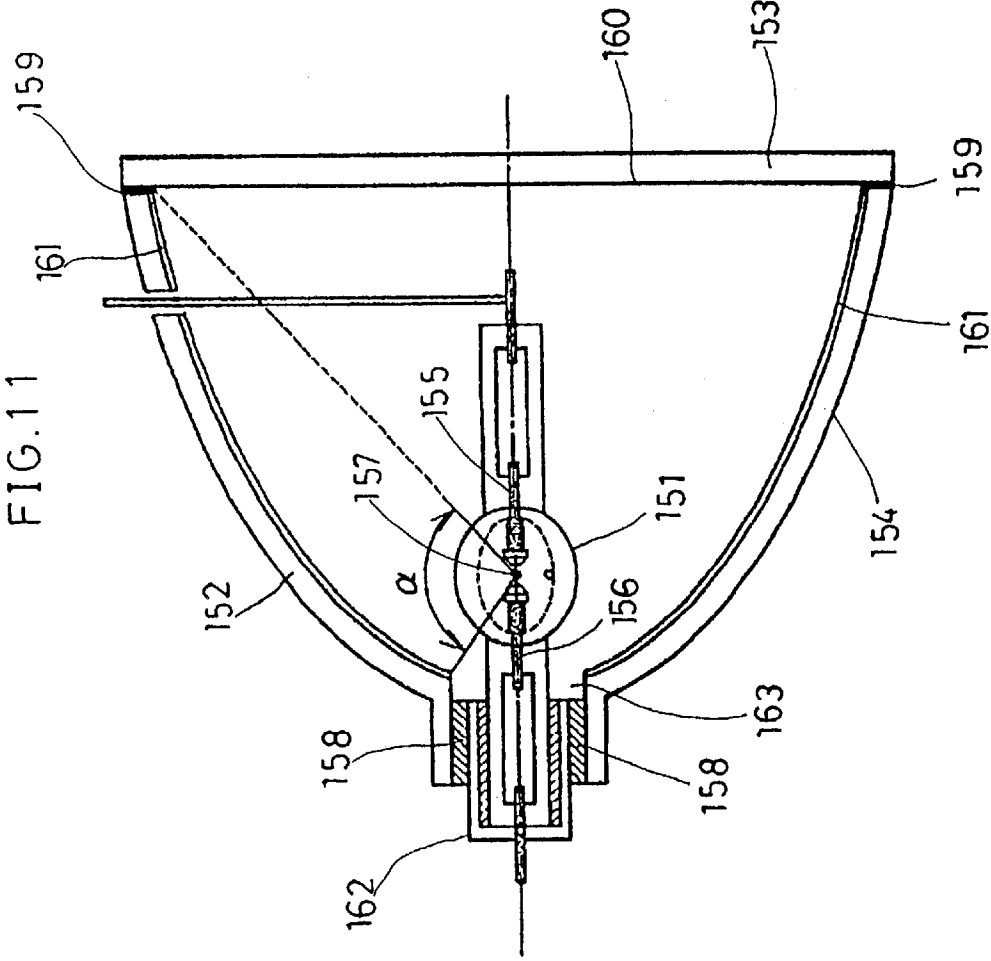
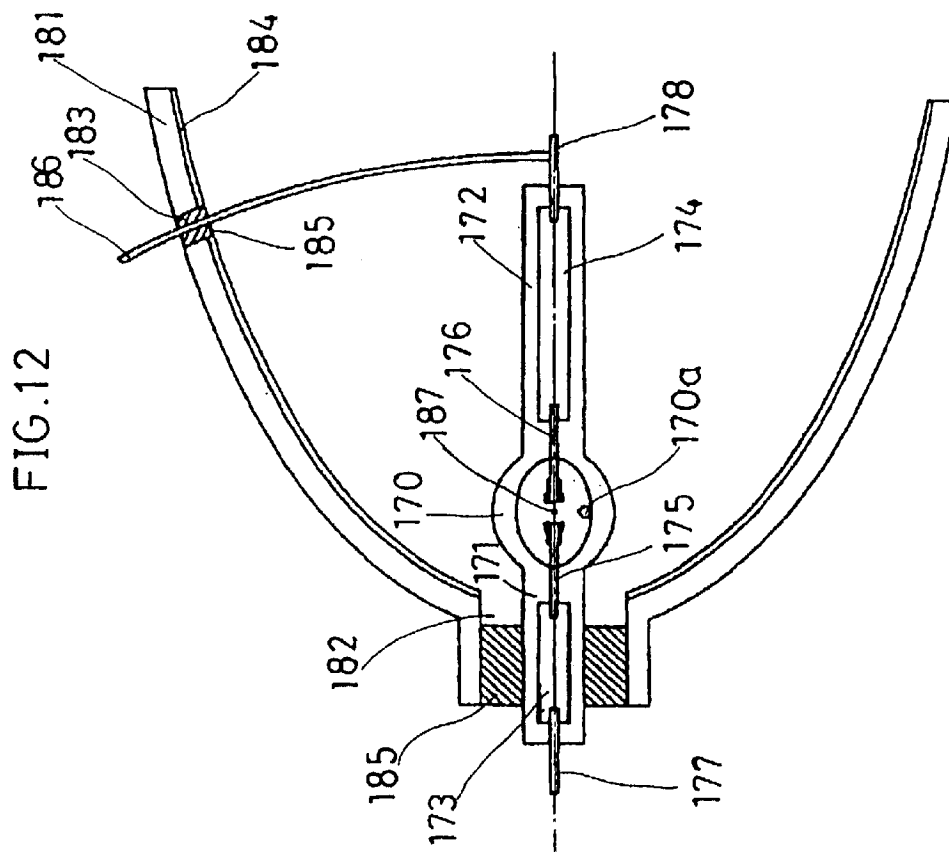


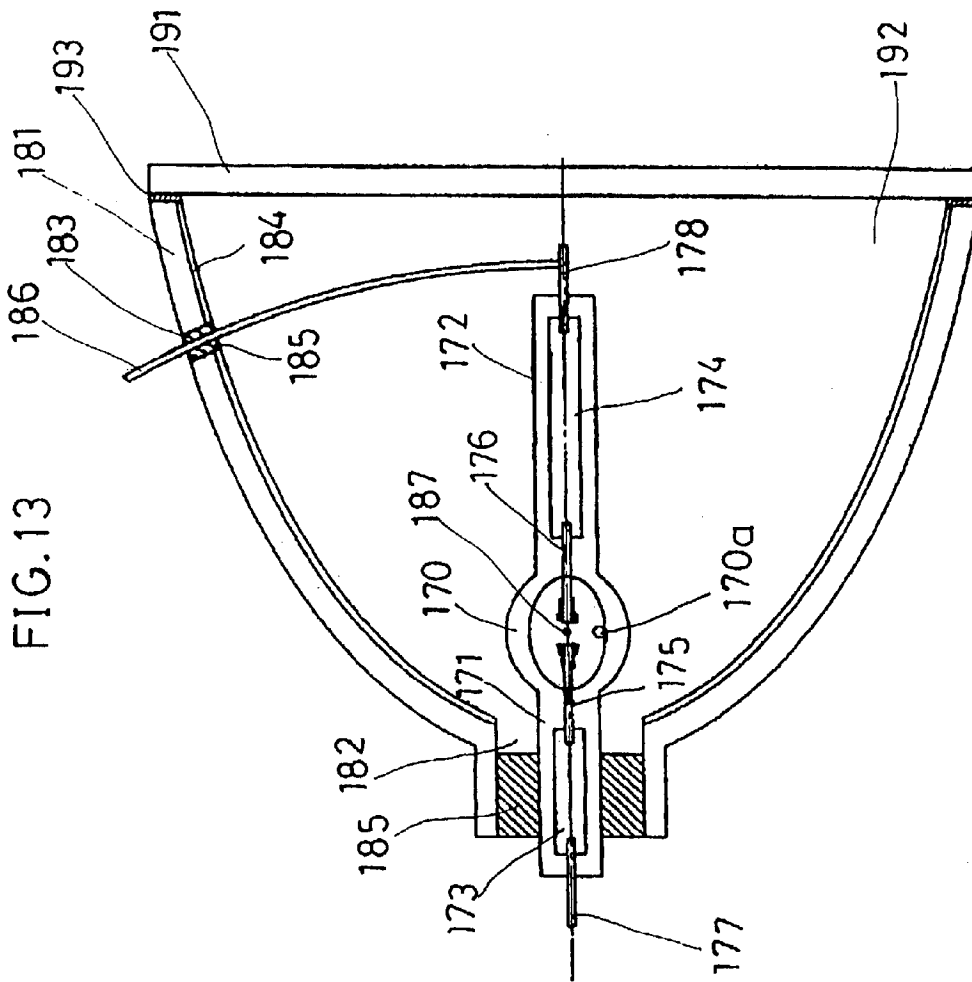
FIG. 10











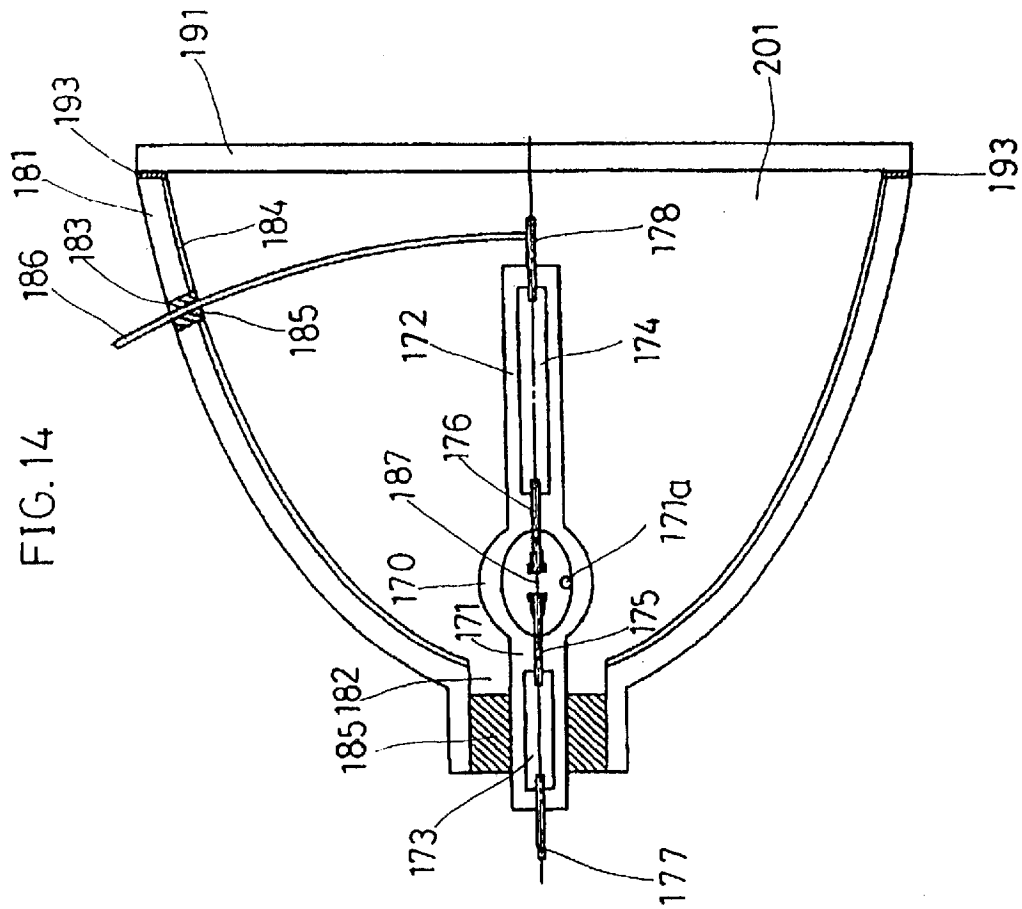


FIG. 15

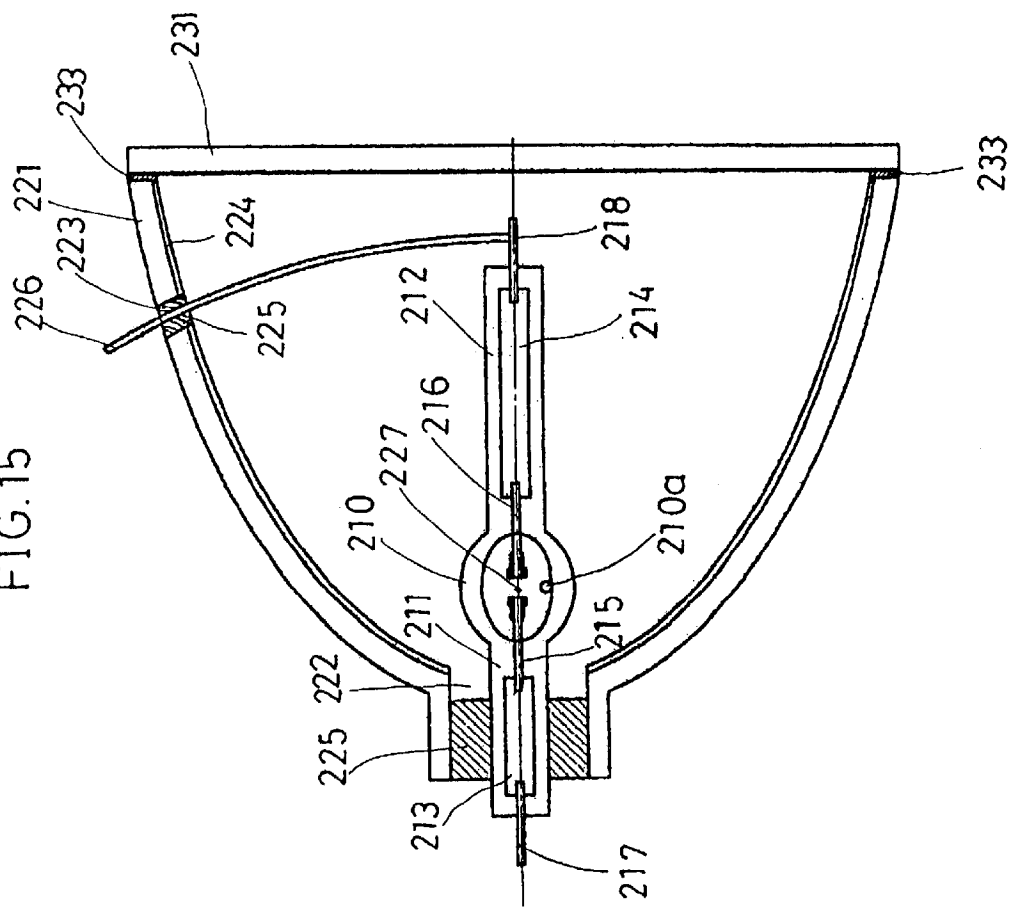


FIG. 16

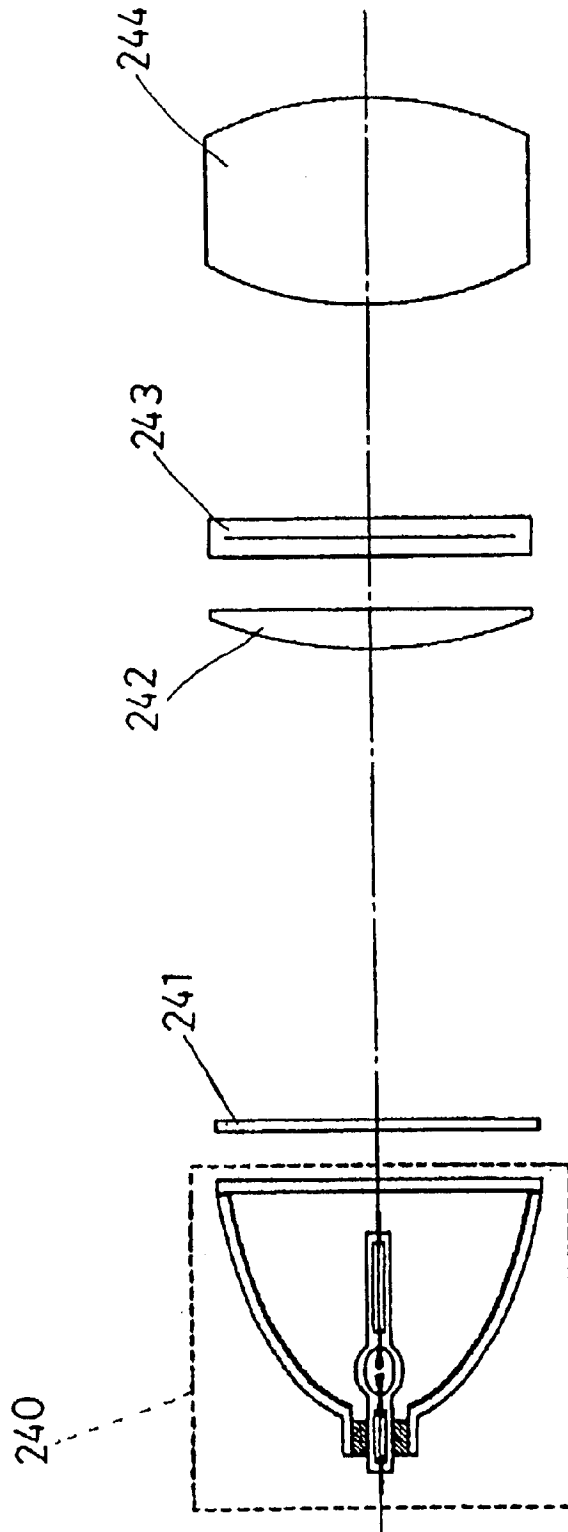
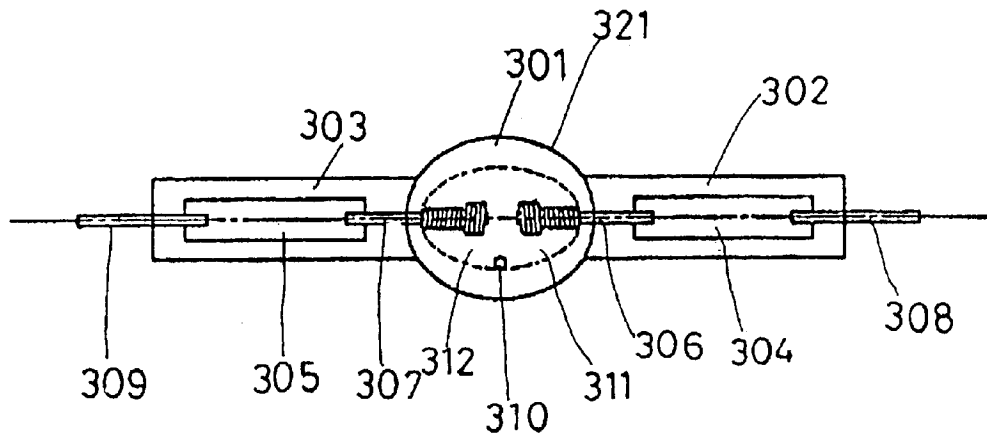
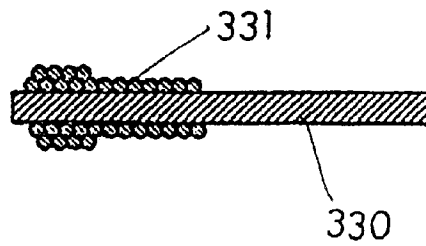


FIG. 17



PRIOR ART

FIG. 18



PRIOR ART

FIG. 19  
PRIOR ART

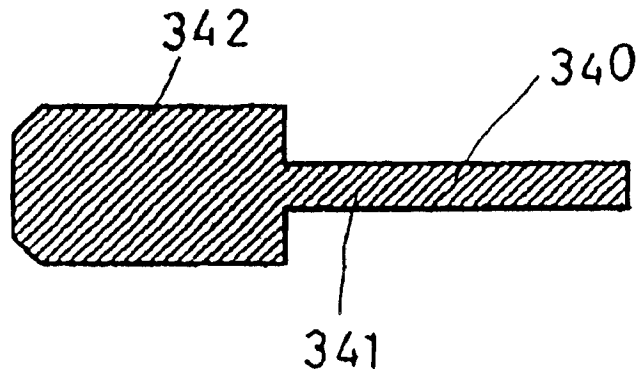
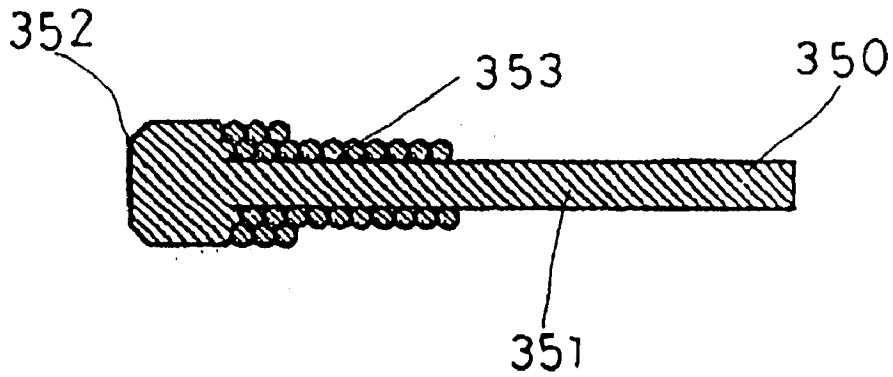
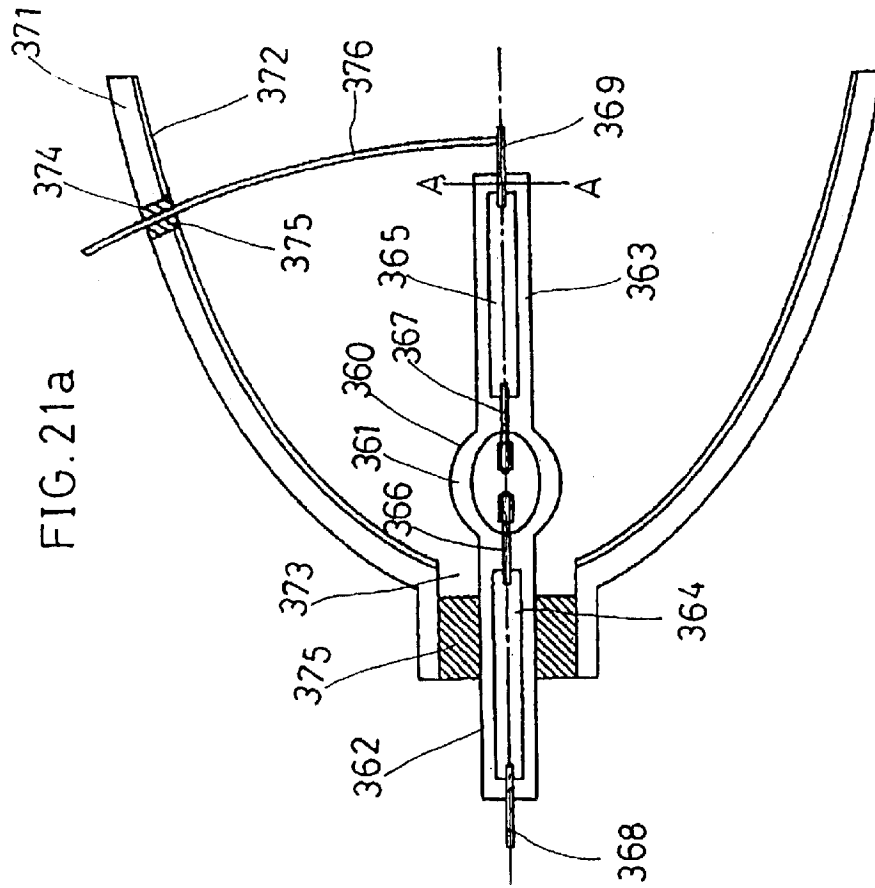


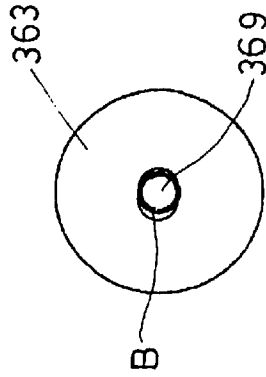
FIG. 20  
PRIOR ART





PRIOR ART

FIG. 21b



PRIOR ART



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## DISCHARGE LAMP, LIGHT SOURCE AND PROJECTING DISPLAY UNIT

This is a divisional of application Ser. No. 09/441,041 filed Nov. 16, 1999, now U.S. Pat. No. 6,559,600.

### FIELD OF THE INVENTION

The present invention relates to a discharge lamp, a light source apparatus which prepares illumination rays using the discharge lamp, and a projection display apparatus which projects a large image onto a screen using the light source apparatus, a spatial light modulating element (for example, a liquid crystal element) for forming an optical image with video signals supplied from outside, and a projector lens.

### BACKGROUND OF THE INVENTION

A small discharge lamp which is denoted by a metalhalide lamp or an ultra high pressure mercury vapor lamp is widely utilized as a light source for a projection display apparatus and the like. In such a case, it is general to combine the discharge lamp with a concave reflector to compose a light source apparatus and utilize this apparatus as a light source for the projection display apparatus.

FIG. 17 exemplifies a configuration of a conventional discharge lamp. A discharge lamp 321 is configured mainly by a light emitting bulb 301, sealing members 302 and 303, metal foils 304 and 305, electrodes 306 and 307, external conductors 308 and 309, and discharge media 310, 311 and 312. Quartz glass is used as the light emitting bulb 301 and sealing members 302, 303, tungsten is used as the electrodes 306 and 307, molybdenum foils are used as the metal foils 304 and 305, and molybdenum is used as the external conductors 308 and 309. Furthermore, mercury, a light emitting metals such as a metalhalide or the like, and a rare gas such as argon or the like, are used mainly as the discharge media 310, 311 and 312, respectively.

When a predetermined voltage is applied across the external conductors 308 and 309, arc discharge takes place between the electrodes 306 and 307, whereby the mercury 310 and the metal halide 311 emit rays characteristic thereof. The argon gas 312 is used to improve a starting characteristic.

Since a distance is extremely short between the electrodes and a high current is supplied at a start time in this kind of discharge lamp, the lamp is liable to be blackened due to deformation of the electrodes and evaporation of an electrode substance, and can hardly have a long service life. In contrast, there have been disclosed various kinds of lamps which are configured to have service lives prolonged by contriving structures of electrodes (for example by JPA 7-192688 and JPA 10-92377). FIGS. 18 through 20 are enlarged views exemplifying configurations of the electrodes.

FIG. 18 shows an example wherein a coil 331 is disposed around a tip of an electrode 330 to enhance a heat dissipation property, thereby preventing a tip portion from being deteriorated or deformed due to excessive temperature rise.

FIG. 19 shows an example wherein a discharge portion 342 which has a diameter larger than that of an electrode shaft 341 is formed at a tip of an electrode 340 to enhance a thermal conductivity, thereby preventing a tip portion from being deteriorated or deformed due to excessive temperature rise. This kind of electrode is used as an anode of a DC type discharge lamp.

FIG. 20 shows an example wherein a discharge member 352 having a diameter larger than that of an electrode shaft

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351 is formed by winding a coil thick around a tip of an electrode 350 and fusing a tip portion so as to form a lump integral with an electrode shaft 351, and a heat dissipating member 353 is formed after the discharge member 352 by integrally fusing a coil, thereby preventing the electrode from being deteriorated or deformed. The heat dissipating member 353 is configured by a coil or a cylindrical electrode member.

However, the electrodes which have configurations shown in FIGS. 18 through 20 pose problems which are described below.

In case of the configuration shown in FIG. 18, a contact area between the electrode 330 and the coil 331 is narrow, whereby the electrode has a low thermal conductivity and cannot exhibit a sufficient heat dissipating effect. Furthermore, the electrode poses a problem that the coil 331 is fused and deformed when the coil 331 is too thin. Though this problem can be solved by thickening the coil 331, tungsten which is used as a material of the electrode 330 is hard and the coil 331 can hardly be wound when it is thick. Furthermore, the electrode poses another problem that a spot of arc discharge moves to the tip of the electrode or an end of the coil, whereby an arc is hardly be stable.

In case of the configuration shown in FIG. 19, the discharge member 342 which is too thick makes the electrode 340 hardly be heated to a temperature required to emit thermoelectrons, thereby posing a problem of degradation of a starting property and interception of discharge. This is remarkably problematic when a lamp is to be lit with an alternating current in particular, whereby the electrode can hardly be used for lighting a lamp with an alternating current.

In case of the configuration shown in FIG. 20 wherein the discharge member 352 is formed integrally and continuously with the coil 353, the discharge portion 352 and the coil 353 have high thermal conductivities and are hardly be raised to a temperature required to emit thermoelectrons, thereby degrading a starting property or allows discharge to be intercepted in the course like the structure shown in FIG. 19. This poses a serious problem when a discharge lamp is to be ignited with an alternating current in particular. Furthermore, an electrode such as that shown in FIG. 20 is manufactured by allowing the electrode having the coil 353 wound around the electrode shaft 351 to discharge in an atmosphere of an inert gas such as nitrogen gas or argon so as to fuse the tip portion. A doping agent such as thorium is often added to tungsten as electrode material for a discharge lamp to improve a starting property. However, the electrode manufactured by the method described above poses a problem that the doping material is evaporated at a stage to fuse the tip portion. Furthermore, the electrode poses another problem that the fusing promotes recrystallization of the tip portion, whereby the electrode is low in its strength and can hardly be worked.

When this kind of discharge lamp is to be used in a projection display apparatus, on the other hand, it is general to configure a light source by combining the discharge lamp with a concave reflector. FIG. 21a exemplifies a configuration of a light source. FIG. 21b is a sectional view taken along an A—A line in FIG. 21a. A reflective coating 372 which is formed on an inside surface of a concave reflector 371 reflects rays emitted from a lamp 360 in a predetermined direction with a high efficiency. A lamp insertion port 373 and a conductor outlet port 374 are formed in the concave reflector 371. The lamp 360 is fixed to the concave reflector 371 with a heat-resistant adhesive agent 375 after inserting

a sealing member **362** is inserted into the lamp insertion port **373**. Furthermore, an end of an extension conductor **376** is connected to an external conductor **369** and the other end of the extension conductor **376** is led out of the concave reflector **371** through the conductor outlet port **374**. Rays can be emitted from the lamp **360** by applying a predetermined voltage across an external conductor **368** and the extension conductor **376**.

It is desired that a lamp which is to be used in the projector display apparatus is as small as possible and has a long service life. However, the conventional light source shown in FIG. **21a** poses problems which are described below.

First, the conventional light source poses a problem that oxidation of metal foils **364** and **365** disposed at both ends of the lamp **360** as well as the external conductors **368** and **369** results in wire breakage, thereby shortening a service life of the lamp. In case of the light source shown in FIG. **21a**, distortion is produced by a thermal stress at a sealing stage, whereby a gap B is formed between the external conductor **369** and a sealing member **363** as illustrated in FIG. **21b** showing an enlarged sectional view taken along the A—A line. Accordingly, the external conductor **369** and an end of the metal foil **365** on a side of the external conductor **369** are kept in contact with air, whereby oxidation of these parts is accelerated in an extremely high temperature condition while the lamp stays lit. When molybdenum is used as the metal foils, for example, the oxidation results in wire breakage in a time of about 5000 hours in air heated to 350° C. though the time is variable dependently on a temperature. The external conductor **368** and the sealing member **362** are also oxidized in the similar manner.

While the discharge lamp used in the projection display apparatus stays lit, the lamp is generally kept at an extremely high temperature and heats a light emitting bulb **361** to a temperature close to 1000° C. at maximum. Accordingly, temperatures reach hundreds of degrees in the vicinities of connected portions between the metal foils **364**, **365** and the external conductors **368**, **369** due to heat conduction from the light emitting bulb **361** as well as electrodes **366** and **367**. Though the temperatures can be lowered by forcible air cooling with a fan or the like, evaporation of the light emitting metal is suppressed and a light emitting efficiency is remarkably lowered when the temperature of the light emitting bulb **361** is lowered. Therefore, it is therefore required to cool the lamp extremely locally with high delicacy.

In order to solve this problem, the conventional discharge lamp uses sufficiently long metal foils, thereby reducing temperature rise due to the heat conduction and preventing the wire breakage due to the oxidation. However, the conventional discharge lamp has a total length which is prolonged by the long metal foils and poses a problem that the lamp makes it difficult to configure a light source compact.

Secondly, the conventional light source poses another problem that evaporation of the light emitting metal which is evaporated while the lamp stays lit enhances an internal pressure of the light emitting bulb to an extremely high level, for example, of several MPas (mega pascals) in case of the metalhalide lamp or of scores of MPas (mega pascals) in case of the super-high pressure mercury lamp, thereby making the light emitting bulb liable to be broken while the lamp stays lit.

#### DISCLOSURE OF THE INVENTION

A primary object of the present invention is to provide a discharge lamp which is improved in a starting property, an

arc stability and service life even when it uses a short arc. Another object of the present invention is to provide a light source apparatus which is suited for use mainly in a projection display apparatus, compact and highly reliable, and efficiently condense rays emitted from a discharge lamp. The light source apparatus according to the present invention makes it possible to provide a projection display apparatus which is bright, compact and highly reliable.

A first discharge lamp according to the present invention is a lamp comprising a light emitting bulb, sealing members disposed at both ends of the light emitting bulb, a pair of electrodes which are disposed in the light emitting bulb so as to oppose to each other at a predetermined spacing and a discharge medium enclosed in the light emitting bulb, wherein the electrode is configured by an electrode shaft and a discharge member which is formed integrally with a tip of the electrode shaft and has an outside diameter larger than that of the electrode shaft, and has a heat dissipating conductor which is disposed at the rear of the discharge member so as to surround the electrode shaft.

A second discharge lamp according to the present invention is a lamp comprising a light emitting bulb, sealing members disposed at both ends of the light emitting bulb, a pair of electrodes which are sealed in the sealing members and disposed in the light emitting bulb so as to oppose to each other at a predetermined spacing and a discharge medium enclosed in the light emitting bulb, wherein the electrode is composed of an electrode shaft and a discharge member which is formed integrally with a tip of the electrode shaft and has an outside diameter larger than that of the electrode shaft, the discharge member has a taper formed on its tip, a heat dissipating conductor surrounding the electrode shaft is disposed at the rear of the discharge member and the electrode satisfies the following conditions:

$$\begin{aligned} \phi/L &\leq 0.6 \\ 20^\circ &\leq \theta \leq 60^\circ \end{aligned}$$

where the reference symbol L denotes the spacing between the electrodes disposed in the light emitting bulb, the reference symbol  $\phi$  denotes a diameter of the tip of the discharge member, and the reference symbol  $\theta$  denotes an angle formed between the tapered tip and the electrode shaft.

A third discharge lamp according to the present invention is a lamp comprising a light emitting bulb, sealing members which are disposed at both ends of the light emitting bulb, a pair of electrodes which are sealed in the sealing members and disposed in the light emitting bulb so as to oppose to each other at a predetermined spacing and a discharge medium enclosed in the light emitting bulb, wherein the electrode is composed of an electrode shaft and a cylindrical conductor fitted over a tip of the electrode shaft, and a heat dissipating conductor is disposed at the rear of the cylindrical conductor so as to surround the electrode shaft.

A fourth discharge lamp according to the present invention is a lamp comprising a light emitting bulb, sealing members which are disposed at both ends of the light emitting bulb, a pair of electrodes which are sealed in the sealing members and disposed in the light emitting bulb so as to oppose to each other at a predetermined spacing and a discharge medium enclosed in the light emitting bulb, wherein the electrode has an electrode shaft, a cylindrical conductor which is fitted over a tip of the electrode shaft and has a tapered outside diametrical portion on a side of the tip of the electrode shaft, a heat dissipating conductor surrounding the electrode shaft is disposed at the rear of the cylindrical conductor and the electrode satisfies the following conditions:

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$$\phi/L \leq 0.6$$

$$20^\circ \leq \theta < 60^\circ$$

where the reference symbol L denotes the spacing between the electrodes disposed in the light emitting bulb, the reference symbol  $\phi$  denotes an outside diameter which is closer to the tip of the electrode shaft in the cylindrical conductor, and the reference symbol  $\theta$  denotes an angle formed between the tapered tip and the electrode shaft.

A fifth discharge lamp according to the present invention is a lamp comprising a light emitting bulb, sealing members disposed at both ends of the light emitting bulb, a pair of electrodes which are sealed in the sealing members and disposed in the light emitting bulb so as to oppose to each other at a predetermined spacing, and mercury and a rare gas which are enclosed in the light emitting bulb, wherein the mercury is enclosed in an amount of 150 mg/cc or more, and the electrode is composed of an electrode shaft and a discharge member which is formed integrally with a tip of the electrode shaft and has an outside diameter larger than that of the electrode shaft, the discharge member has a tapered tip, a heat dissipating conductor surrounding the electrode shaft is disposed at the rear of the discharge member, and the electrode satisfies the following conditions:

$$\phi/L \leq 0.6$$

$$20^\circ \leq \theta \leq 60^\circ$$

where the reference symbol L denotes the spacing between the electrodes, the reference symbol  $\phi$  denotes a diameter of the tip of the discharge member, and the reference symbol  $\theta$  denotes an angle formed between the tapered tip and the electrode, and wherein the discharge lamp is configured to be lit by applying an AV voltage across the electrodes.

It is preferable for the third or fourth discharge lamp described above that a taper is formed on an inside end which is far from the tip of the electrode shaft.

It is preferable for any of the first through fifth discharge lamps described above that the heat dissipating conductor has a form of a coil.

It is preferable for any of the first through fifth discharge lamps described above that the electrodes and the heat dissipating conductor are made of different materials.

It is preferable for any of the first through fifth discharge lamps described above that the electrodes are made of tungsten doped with thorium.

Furthermore, it is preferable for any of the first, second or fifth discharge lamps described above that the spacing between the electrodes does not exceed 2 mm and that the electrode satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0$$

$$D3/D1 \leq 9.0$$

where the reference symbol D1 denotes an outside diameter of the electrode shaft, the reference symbol D2 denotes an outside diameter of the discharge member, and the reference symbol D3 denotes a length of the discharge member as measured in a direction of the electrode shaft.

It is preferable for the third or fourth discharge lamp described above that the spacing between the electrode does not exceed 2 mm and that the electrode satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0$$

$$D3/D1 \leq 9.0$$

6

where the reference symbol D1 denotes an outside diameter of the electrode shaft, the reference symbol D2 denotes an outside diameter of the cylindrical conductor, and the reference symbol D3 denotes a length of the cylindrical conductor as measured in a direction of the electrode shaft.

It is preferable for any of the first through fourth discharge lamps described above that the discharge medium is mercury and a rare gas.

It is preferable for any of the first through fourth discharge lamps described above that the lamp is lit by applying an AC voltage across the electrodes.

It is preferable for any of the first through fourth discharge lamps described above that the lamp is lit by applying a DC voltage across the electrodes and that a polarity of the voltage is reversed, depending on a drive time and a number of ignitions.

It is preferable for any of the first through fifth discharge lamps described above that the electrode is made of pure tungsten having a content of at least one of potassium, silicon and aluminium which does not exceed 10 ppm.

The present invention is capable of providing a discharge lamp which is excellent in a starting property and has a long service life even if it uses a short arc.

A first light source apparatus according to the present invention comprises any of the first through fifth discharge lamps described above and a concave reflector which reflects rays emitted from the discharge lamp in predetermined directions.

A second light source apparatus according to the present invention comprises the second, fourth or fifth discharge lamp described above and a concave reflector which reflects rays emitted from the discharge lamp in predetermined directions, and is characterized in that the concave reflector has an opening through which reflected rays are emitted and a lamp insert portion which is disposed on a side opposite to the opening, that the discharge lamp is disposed so that its one end is inserted into the lamp insert portion and a center of a light emitting area formed between the electrodes is approximately coincident with a shorter focal point of the concave reflector and that rays which are emitted from the center of the light emitting area and incident onto an effective reflecting surface of the concave reflector are not intercepted by the electrodes of the discharge lamps.

A third light source apparatus according to the present invention is an apparatus comprising a discharge lamp and a concave reflector which reflects rays emitted from the discharge lamp in predetermined directions, wherein the discharge lamp comprises metal foils which are sealed in sealing members disposed at both ends of a light emitting bulb and different in lengths, the concave reflector has an opening through which reflected rays are emitted and a lamp insert hole disposed on a side opposite to the opening, and the discharge lamp is disposed so that a sealing member in which a metal foil having a shorter length is sealed is inserted into the lamp insert hole and a center of a light emitting area formed in the light emitting bulb is approximately coincident with a shorter focal point of the concave reflector.

A fourth light source apparatus according to the present invention is an apparatus comprising a discharge lamp, a concave reflector which reflects rays emitted from the discharge lamp in predetermined directions and light transmittal enclosing means which is disposed in an opening for emitting rays reflected by the concave reflector to form an enclosed space in the concave reflector, wherein an inert gas is enclosed in the closed space.

A fifth light source apparatus according to the present invention is an apparatus comprising a discharge lamp, a

concave reflector which reflects rays emitted from the discharge lamp in predetermined directions and light transmittal enclosing means which is disposed in an opening for emitting rays reflected by the concave reflector to form an enclosed space in the concave reflector, wherein a gas is enclosed in the enclosed space at a pressure higher than an atmospheric pressure and lower than a working pressure of the discharge lamp.

A sixth light source apparatus according to the present invention is an apparatus comprising a discharge lamp having a working pressure not lower than 10 MPas (mega pascals) a concave reflector which reflects rays emitted from the discharge lamp in predetermined directions and transmittal enclosing means, wherein the discharge lamp has metal foils which are disposed at both ends of a light emitting bulb and different in lengths, the concave reflector has an opening for emitting rays reflected by the concave reflector and a lamp insert hole disposed on a side opposite to the opening, the discharge lamp is disposed so that a sealing member in which a metal foil having a shorter length is sealed is inserted into the lamp insert hole and a center of a light emitting area formed in the light emitting bulb is approximately coincident with a shorter focal point of the concave reflector.

It is preferable for the fourth or fifth light source apparatus described above that the concave reflector is an ellipsoidal mirror.

It is preferable for the fourth or fifth light source apparatus described above that the discharge lamp has a working pressure which is not lower than 10 MPas (mega pascals).

It is preferable for the third or sixth light source apparatus described above that the concave reflector is an ellipsoidal mirror and a distance as measured from a vertex of the lamp insert portion of an ellipsoidal to an end of a longer metal foil on a side of the opening of the concave reflector does not exceed  $\frac{1}{2}$  of a length of a major axis of the ellipsoidal surface.

The present invention makes it possible to obtain a light source apparatus which is capable of effectively condensing rays emitted from a lamp. Furthermore, the present invention makes it possible to obtain a light source apparatus which is compact and highly reliable.

A projection display apparatus according to the present invention is an apparatus comprising a light source, image forming means which is illuminated with the light source and forms an optical image in correspondence to video signals and projecting means which projects an optical image formed on the image forming means to a screen, characterized in that the light source is any of the first through sixth light source apparatus described above.

The present invention makes it possible to obtain a projection display apparatus which is compact, highly reliable and bright.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a is a schematic configurational view showing a first embodiment of a discharge lamp according to the present invention;

FIG. 1b is an enlarged view showing a configuration of an electrode in the first embodiment;

FIG. 2a is a schematic configurational view showing a second embodiment of the discharge lamp according to the present invention;

FIG. 2b is an enlarged view showing a configuration of the electrode in the second embodiment;

FIG. 3 is an enlarged view showing another configuration of an electrode in the second embodiment;

FIG. 4a is a schematic configurational view showing a third embodiment of the discharge lamp according to the present invention;

FIG. 4b is an enlarged view showing a configuration of an electrode in the third embodiment;

FIG. 5 is an enlarged view showing another configuration of the electrode in the third embodiment;

FIG. 6 is an enlarged view showing still another configuration of the electrode in the third embodiment;

FIG. 7a is a schematic configurational view showing a fourth embodiment of the discharge lamp according to the present invention;

FIG. 7b is an enlarged view showing a configuration of an electrode in the fourth embodiment;

FIG. 8a is a schematic configurational view showing a fifth embodiment of the discharge lamp according to the present invention;

FIG. 8b is an enlarged view showing a configuration of an electrode in the fifth embodiment;

FIG. 9 shows characteristic curves visualizing relationship between taper angles and rise times;

FIG. 10 is a schematic view showing a first embodiment of a light source apparatus according to the present invention;

FIG. 11 is a schematic view showing a second embodiment of the light source apparatus according to the present invention;

FIG. 12 is a schematic configurational view showing a third embodiment of the light source apparatus according to the present invention;

FIG. 13 is a schematic configurational view showing a fourth embodiment of the light source apparatus according to the present invention;

FIG. 14 is a schematic configurational view showing a fifth embodiment of the light source apparatus according to the present invention;

FIG. 15 is a schematic configurational view showing a sixth embodiment of the light source apparatus according to the present invention;

FIG. 16 is a schematic configurational view showing an embodiment of a projection display apparatus according to the present invention;

FIG. 17 is a schematic view showing a configuration of a conventional discharge lamp;

FIG. 18 is a schematic view showing a configuration of an electrode of a conventional discharge lamp;

FIG. 19 is a schematic view showing another configuration of the electrode of the conventional discharge lamp;

FIG. 20 is a schematic view showing still another configuration of the electrode of the conventional discharge lamp;

FIG. 21a is a schematic view showing a configuration of a conventional light source apparatus; and

FIG. 21b is an enlarged sectional view taken along an A—A line in FIG. 21a.

#### DESCRIPTION OF THE EMBODIMENTS

Now, the preferred embodiments of the present invention will be described with reference to the accompanying drawings.

FIGS. 1a and 1b exemplify a configuration as a first embodiment of a discharge lamp according to the present invention. FIG. 1b is an enlarged sectional showing an electrode used in the first embodiment shown in FIG. 1a.

A reference numeral **10** denotes a light emitting bulb, reference numerals **11** and **12** denote sealing members, reference numerals **13** and **14** denote metal foils, reference numerals **15** and **16** denote electrodes, reference numerals **17** and **18** denote coils adopted as heat dissipating conductors, reference numerals **19** and **20** denote external conductors, reference numerals **21** and **22** denote mercury and argon gas used as discharge media, and a reference numeral **31** denotes a discharge lamp according to the present invention.

The light emitting bulb **10** is a bulb of transparent quartz glass which has an outside diameter of 15 mm, a maximum thickness of 3 mm and an spherical or ellipsoidal internal discharge space. The transparent quartz glass is excellent in heat resistance and suited as a material for the discharge lamp which is used at an extremely high working temperature. The transparent quartz glass has another merit to have high light transmittance. Another material having a high thermal conductivity such as sapphire glass may be used. A high thermal conductivity provides a merit that it uniformizes a temperature distribution in the light emitting bulb **10**, thereby stabilizing a light emitting characteristic and facilitating to cool the light emitting bulb **10**.

The sealing members **11** and **12** are disposed at both ends of the light emitting bulb **10**. Like the light emitting bulb **10**, the sealing members **11** and **12** are made of the transparent quartz glass. The metal foils **13** and **14** 13.5 mm wide by 16 mm long are sealed in the sealing members **11** and **12**, respectively. The metal foils **13** and **14** are made of molybdenum which is a metal having a high fusion point.

Ends of the electrodes **15** and **16** are connected to the metal foils **13** and **14**, and the other ends of the electrodes are disposed in the light emitting bulb **10** so as to oppose to each other at a interval distance of 2.0 mm. The electrode **15** is composed of an electrode shaft **15a** and a discharge member **15b** which has a diameter larger than that of the electrode shaft and is formed integrally with the electrode shaft as shown in FIG. **1b**. Pure tungsten is used as a material for the electrode **15**. The electrode **15** can be obtained easily by cutting a cylindrical electrode material. Furthermore, the electrode **15** having a predetermined form may be molded using molding dies made of molybdenum, carbon or a ceramic material. The electrode shaft **15a** and the discharge member **15b** have outside diameters of 1.0 mm and 3.0 mm, respectively. The discharge member **15b** is 1.8 mm long in an axial direction. At the rear of the discharge member **15b**, a coil **17** is wound around the electrode shaft **15a**. The coil **17** is made of pure tungsten wire having a diameter of 0.5 mm. The coil **17** may be fixed to the electrode shaft **15a**, for example, by spot welding. The electrode **16** is composed similarly of an electrode shaft **16a** and a discharge member **16b** which has a diameter larger than that of the electrode shaft **16a**, and a coil **18** is wound around the electrode shaft **16a** at the rear of the discharge member **16b**.

Each of the ends of the external conductors **19** and **20** is connected to the metal foils **13** and **14** and the other end of the external conductors protrude out of the sealing members **11** and **12**, respectively. Like the metal foils **13** and **14**, the external conductors **19** and **20** are made of molybdenum. By applying a predetermined voltage across the external conductors **19** and **20**, it is possible to allow an arc discharge to take place between the electrodes **15** and **16**, thereby obtaining emission characteristic of the mercury **21** as it is evaporated. Furthermore, the argon gas **22** is enclosed as a rare gas at a predetermined pressure to improve a starting property of the lamp.

In addition to argon gas, an inert gas such as xenon gas may be used as a rare gas, which can improve the starting

property. Furthermore, a predetermined amount of halogen gases, for example, iodine, bromine and chlorine may be enclosed together with the rare gas mentioned above. The halogen gases serve to prolong a service life of the lamp since the gases combined with tungsten used as the material for the electrodes and produce a halogen cycle, thereby preventing an inside wall of the light emitting bulb from being blackened due to splashing of tungsten while the lamp stays lit.

When the discharge lamp **31** is composed using the electrodes **15** and **16**, a light emitting area formed by arc discharge between the discharge members **15b** and **16b** which have the large diameter. Since the discharge members **15b** and **16b** have a large thermal capacity and a high thermal conductivity, the discharge members exhibit an effect to suppress overheat of the electrodes **15** and **16** even if a relatively high current is supplied. Accordingly, the discharge members remarkably reduce deformation of the electrodes **15** and **16** and evaporation of an electrode substance, thereby prolonging the service life of the lamp. The coils **17** and **18** which enhance a heat dissipating property of the electrode shafts **15a** and **16a** to suppress overheat of the electrodes, thereby preventing the electrode shafts from being thinned or broken. Furthermore, the electrodes **15** and **16** do not make an arc spot unstable unlike the electrode shown in FIG. **17**, thereby being capable of stabilizing light emission. Since the electrodes **15** and **16** are not fused integrally with the coils **17** and **18** but kept separate from the coils, the discharge members **15b**, **16b** and the coils **17**, **18** have low thermal conductivities. Furthermore, since the discharge members **15b** and **16b** have a form which is adequately selected so that these members do not have too large a thermal capacity, the discharge members **15b** and **16b** are not cooled excessively and can easily be heated to a temperature sufficient for emission of thermoelectrons, thereby remarkably improving a starting property as compared with that obtained with an electrode shown in FIGS. **19** and **20**.

The configuration according to the present invention makes it possible to obtain a discharge lamp which is excellent in a starting property and has a long service life despite of a shorter arc, using electrodes which are composed of electrode shafts and discharge members formed integrally with tips of the electrode shafts and having a diameter larger than that of the electrode shafts, and disposing heat dissipating conductors after the discharge members so as to surround the electrode shafts as described above.

FIGS. **2a** and **2b** exemplify a configuration of a second embodiment of the discharge lamp according to the present invention. Incidentally, FIG. **2b** is an enlarged sectional view illustrating an electrode member shown in FIG. **2a**.

A discharge lamp **51** has a configuration which is the same as that shown in FIG. **1a**, except electrodes **41** and **42**. Different from the electrode shown in FIG. **1a**, the electrode **41** has a taper **41c** formed on a tip of a discharge member **41b** which composes the electrode **41**. The taper **41c** is formed at an angle of 45° relative to an electrode shaft **41a** and the tip of the discharge member **41b** has a circular sectional shape having a diameter of 1.0 mm. Like the electrode **41**, the electrode **42** has a taper **42c** which is formed at angle of 45° relative to an electrode shaft **42a**.

The second embodiment provides, in addition to those obtained with the embodiment shown in FIGS. **1a** and **1b**, effects which are described below. When the tapers **41c** and **42c** are formed on the tips of the discharge members **41b** and **42b** to reduce a diameter  $\phi$  of the tips, an electron emission

property is enhanced and a starting property is improved as compared with that of the embodiment shown in FIGS. 1a and 1b. Simultaneously, the tapers also remarkably shorten a rise time required until the lamp reaches a stable state. Since thermoelectrons are emitted mainly from the tips of the discharge members 41b and 42b, the tapers provide a merit to remarkably reduce a diametrical width of an arc is remarkably reduced as compared with that of an arc which is produced without the tapers 41c and 42c, thereby enhancing luminance of a light emission area. Furthermore, the discharge members 41b and 42b which have the small diameter  $\phi$  hardly allow movement of an arc spot the tips, or the so-called bright point movement, thereby enhancing arc stability during ignition of the lamp. Furthermore, the tapers can narrow a range wherein rays emitted from the light emitting area are intercepted by the discharge members 41b and 42b which have the large diameter, thereby making it possible to utilize the emitted rays with a high efficiency. In addition, the tapers allow the electrodes to be worked easier than the electrode shown in FIG. 20, thereby enhancing production yield of the electrodes.

In order to obtain sufficient effects of the present invention, it is sufficient to satisfy the following conditions:

$$\phi/L \leq 0.6 \quad (\text{Equation 1})$$

$$20^\circ \leq \theta \leq 60^\circ \quad (\text{Equation 2})$$

where the reference symbol L denotes a spacing between the electrodes 41 and 42 disposed in the light emission bulb 10, the reference symbol  $\phi$  denotes a diameter of the tips of the discharge members 41b and 42b, and the reference symbol  $\theta$  denotes an angle formed between the tapers 41c, 42c and the electrode shafts 41a and 42a.

$\phi/L$  which is larger than an upper limit value of the Equation 1 is not preferable since it lowers the effects for the starting property, rise time and arc stability described above. Furthermore,  $\phi/L$  which is larger than the upper limit is not preferable since it increases an amount of rays to be intercepted by the discharge members 41b and 42b.

$\theta$  which is smaller than a lower limit value of the Equation 2 is not preferable since it makes the tips of the discharge members 41b and 42b too thin, thereby allowing the electrodes 41 and 42 to be easily deteriorated. Furthermore,  $\theta$  which is larger than an upper limit value of the Equation 2 is not preferable since it lowers the effects for the starting property, rise time and arc stability. Furthermore,  $\theta$  larger than the upper limit value is not preferable since it increases the amount of rays to be intercepted by the discharge members 41b and 42b.

The electrode may be an electrode 45 which has a spherical tip as shown in FIG. 3. In case of this electrode, a diameter  $\phi$  of a tip of a discharge member 45b is to be defined as a distance between tangential points between an outer circumference 46 of a sphere and a taper 45c.

As described above, according to the configuration of the present invention, the electrode is used which comprises the electrode shaft and the discharge member which is formed integrally with the tip of the electrode shaft, has an outside diameter larger than that of the electrode shaft and has a taper, and the heat dissipating conductor is provided at the rear of the discharge member so as to surround the electrode shaft. Thereby, the discharge lamp can be realized which is easily manufactured, does not induce unstable discharge, is excellent in a starting property and rise time performance, is capable of efficiently utilizing emitted rays and is long in a service life even with a short arc.

FIGS. 4a and 4b show an example of configuration illustrating a third embodiment of the discharge lamp

according to the present invention. FIG. 4b is an enlarged sectional view of an electrode shown in FIG. 4a.

A discharge lamp 71 has a configuration which is the same as that shown in FIG. 1a, except electrodes 61 and 62. Different from the electrode shown in FIG. 1a, the electrode 61 is configured by an electrode shaft 61a and a cylindrical conductor 61b which is disposed on a tip of the electrode shaft 61a. The electrode shaft 61a has an outside diameter of 1.0 mm and is made of pure tungsten. The cylindrical conductor 61b has an outside diameter of 3.0 mm. The cylindrical conductor 61b is 1.8 mm long as measured in an axial direction, made of pure tungsten and fitted over the tip of the electrode shaft 61a. The cylindrical conductor 61b can be fixed to the electrode shaft 61a, for example, by spot welding. Like the electrode 61, the electrode 62 has a cylindrical conductor 62b disposed at a tip thereof.

Heat which is generated by the electrode shafts 61a and 62a is dissipated by way of the cylindrical conductors 61b and 62b. Since the electrode shafts 61a and 62a have a high contact property and a high thermal conductivity, heat is dissipated efficiently from the tips of the electrode shafts 61a and 62a which are heated to a highest temperature. The electrode uses the tip which is configured separate from the electrode shaft unlike the electrode shown in FIG. 1b and eliminates a necessity to form the tip by cutting, thereby providing a merit that it can be manufactured easier.

The electrode 61b allows heat conducted after the electrode shaft 61a to be dissipated efficiently by disposing a heat dissipating conductor such as a coil 65, thereby being capable of preventing the electrode shaft 61a from being thinned or broken. The electrode 62 also exhibits a similar effect.

Though end surfaces of the electrode shafts 61a and 62a are slush with end surfaces of the cylindrical conductors 61b and 62b in FIGS. 4a and 4b, the cylindrical conductors may be fitted so that the tips of the electrode shafts 61a and 62a protrude slightly from the end surfaces of the cylindrical conductors 61b and 62b.

The electrode 61 can be configured as an electrode 66 shown in FIG. 5 which uses a cylindrical conductor 66b having a notched taper 67 formed on an inner circumference on a side farther from a tip of an electrode shaft 66a. The taper 67 provides an effect to further enhance a heat dissipating property by enlarging a surface area of the cylindrical conductor 66b. Simultaneously, a starting property can further be improved by adjusting an angle  $\eta$  of the taper 67 so as to obtain an adequate contact area between the electrode shaft 66a and the cylindrical conductor 66b. A heat dissipating conductor such as the coil 65 may be disposed at the rear of the cylindrical conductor 66b. The electrode 62 can also be configured similarly.

Furthermore, similar effects can be obtained with an electrode 68 composed by fitting a tip of an electrode shaft 68a into a cylindrical conductor 68b having an inner circumference which does not run through the conductor as shown in FIG. 6. It is possible to dispose a heat dissipating conductor such as the coil 65 and an inner circumferential taper similar to that shown in FIG. 5.

The configuration according to the present invention makes it possible to obtain a discharge lamp which is easily manufactured, does not induce unstable discharge, and has an excellent starting property and a long service life despite of the shorter arc, using the electrodes composed of the electrode shafts and the cylindrical conductors fitted over the tips of the electrode shafts.

FIGS. 7a and 7b show an example of configuration of a fourth embodiment of the discharge lamp according to the

present invention. Incidentally, FIG. 7b is an enlarged sectional view of an electrode shown in FIG. 7a.

A discharge lamp 91 has a configuration which is the same as that shown in FIG. 4a, except for electrodes 81 and 82. Different from the electrode shown in FIG. 4a, the electrode 81 uses a cylindrical conductor 81b which has a taper 81c on its tip. The taper 81c is formed at an angle of 45° relative to an axial line of the electrode 81 and a tip of the cylindrical conductor 81b has an outside diameter of 1.0 mm which is the same as an outside diameter of an electrode shaft 81a. Like the electrode 81, the electrode 82 has a taper 82c formed on a cylindrical conductor 82b. A heat dissipating conductor such as a coil 85 which is disposed at the rear of the cylindrical conductor 81b serves to efficiently dissipate heat conducted backwards the electrode shaft 81a, thereby being capable of preventing the electrode shaft 81a from being thinned or broken. The electrode 82 is configured similarly.

The fourth embodiment not only provides the effect of the third embodiment shown in FIGS. 4a and 4b but also further improves a starting property and a rise time. Simultaneously, the fourth embodiment provides a merit to enhance luminance of a light emitting area. Furthermore, the fourth embodiment hardly allows a bright point to move, thereby enhancing an arc stability during ignition of the lamp. Furthermore, the fourth embodiment narrows an area at which rays emitted from a light emitting area are intercepted by the cylindrical conductors 81b and 82b, thereby making it possible to efficiently utilize the emitted rays.

To obtain sufficient effects of the present invention, it is sufficient to satisfy the following conditions:

$$\phi/L \leq 0.6 \quad (\text{Equation 3})$$

$$20^\circ \leq \theta \leq 60^\circ \quad (\text{Equation 4})$$

where the reference symbol L denotes a spacing between the electrodes 81 and 82 disposed in the light emitting bulb 10, the reference symbol  $\phi$  denotes an outside diameter of end surfaces of the cylindrical conductors 81b and 82b close to the tips of the electrode shafts 81a and 82a, and the reference symbol  $\theta$  denotes an angle formed between the tapers 81c, 82c and the electrodes 81, 82.

$\phi/L$  which is larger than an upper limit value of the Equation 3 is not preferable since it lowers the effects for the starting property, rise time and arc stability described above. Furthermore,  $\phi/L$  which is larger than the upper limit value is not preferable since it increases an amount of rays to be intercepted by the cylindrical conductors 81b and 82b.

$\theta$  which is smaller than a lower limit value of the Equation of the 4 is not preferable since it makes the tips of the cylindrical conductors 81b and 82b too thin, thereby making the electrodes 81 and 82 liable to be deteriorated. In contrast,  $\theta$  which is larger than an upper limit value of the Equation 4 is not preferable since it lowers the effect for the starting property, rise time and arc stability described above. Furthermore,  $\theta$  which is larger than the upper limit value is not preferable since it increases an amount of rays to be intercepted by the cylindrical conductors 81b and 82b.

The configuration according to the present invention makes it possible to obtain a discharge lamp which can easily be manufactured, does not induce unstable discharge, is excellent in a starting property and rising performance at an ignition time, permits efficiently utilizing emitted rays and has a long service life even with a short arc using the electrode composed of the electrode shaft and the cylindrical conductors which have the tapered outside diametrical portions on the side of the tip of the electrode shaft as described above.

FIGS. 8a and 8b exemplify a configuration which is a fifth embodiment of the discharge lamp according to the present invention. Incidentally, FIG. 8b is an enlarged sectional view of an electrode shown in FIG. 8a.

A discharge lamp 121 is an ultra high pressure mercury vapor lamp to be ignited with an AC current. Ultra high pressure mercury vapor lamps are compact and highly luminant at light emitting areas, thereby being used widely for projection display apparatuses. Generally speaking, this kind of lamps are used mainly for horizontal lighting.

A light emitting bulb 101 is a quartz glass bulb having an outside diameter of 12 mm and a maximum thickness of 2.5 mm, and a molybdenum foils 104 and 105 of 2.5 mm wide by 20 mm long are enclosed in sealing members 102 and 103. Electrodes 106 and 107 which are connected to the molybdenum foils 104 and 105 and made of pure tungsten are disposed so as to oppose to each other in the light emitting bulb 101 at an interval distance of 1.5 mm. Enclosed in the light emitting bulb 101 are mercury at 170 mg/cc, argon gas at 200 mb and an extremely fine amount of bromine. Bromine serves to prevent an inside wall of the light emitting bulb 101 from being blackened by tungsten evaporated from the electrodes 106 and 107, thereby prolonging a service life of the lamp 121.

Mercury 110 can be glowed by applying an AC voltage having a predetermined frequency across external conductors 108 and 109 which are connected to the molybdenum foils 104 and 105. The lamp 121 is set at an electric power of 200 W in its stable state.

The electrode 106 is configured by an electrode shaft 106a and a discharge member 106b which has a diameter larger than that of the electrode shaft 106a. The discharge member 106a has a diameter of 0.5 mm. The discharge member 106b has an outside diameter of 1.8 mm, a tip diameter of 0.3 mm, a length of 2.5 mm in an axial direction and a taper angle of 30°. A heat dissipating conductor such as a coil 112 is disposed at the rear of the discharge member 106b so that heat conducted backwards the electrode shaft 106a can be efficiently dissipated, thereby preventing the electrode shaft 106a from being thinned or broken. The electrode 107 has a similar configuration.

Since the distance between the electrodes 106 and 107 is as short as 1.5 mm, a light emitting area having remarkably high luminance is formed between the electrodes. By composing the discharge lamp 121 by using the electrodes 106 and 107, it is possible to suppress deterioration of the electrodes and to prolong a service life of the lamp even if the light emitting area has high luminance and the electrodes 106 and 107 generate heat in an extremely large amount. Furthermore, since an adequate form is selected for the discharge member 106b, the lamp has a favorable starting property, a short rise time and a high arc stability during ignition. In addition, the lamp can efficiently utilize emitted rays since the electrodes 106 and 107 are configured to intercept rays emitted from the light emitting area only within a narrow area.

FIG. 9 visualizes relationship between an angle of tapers 106c, 107c and a rise time with respect to the discharge lamp shown in FIG. 8: an abscissa denoting a time after ignition and an ordinate designating an optical output. The optical output denoted by the ordinate expresses a relative value which is calculated taking an optical output of the lamp in a stable state as 1.0. As compared with a lamp which uses a conventional electrode shown in FIG. 14, the discharge lamp according to the present invention has a remarkably shortened rise time. The rise time is prolonged as the tapers 106c and 107c have a larger angle, and favorable rising perfor-

mance can be obtained within a range from 20° to 60° of the angle of the tapers **106c** and **107c**.

To obtain sufficient effects of the present invention, it is sufficient to satisfy the following conditions:

$$\phi/L \leq 0.6 \quad (\text{Equation 5})$$

$$20^\circ \leq \theta \leq 60^\circ \quad (\text{Equation 6})$$

where the reference symbol L denotes a spacing between the electrodes disposed in the light emitting bulb, the reference symbol  $\phi$  denotes a diameter of the discharge member, and the reference symbol  $\theta$  denotes an angle formed between the taper and the electrode shaft.

By adopting the electrodes which have the discharge members having a diameter larger than that of the electrode shaft and selecting an adequate form for the discharge members, the configuration according to the present invention makes it possible to obtain a discharge lamp which is excellent in a starting property and rising performance without inducing any unstable discharge, capable of efficiently utilizing rays and long in a service life even with a short arc, even when the lamp is an ultra high pressure mercury vapor lamp or the like which imposes a heavy load on electrodes.

It is preferable that the discharge lamp preferred as the first, second or fifth embodiment has a spacing of 2 mm or shorter between the electrodes and satisfies embodiment described above satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0 \quad (\text{Equation 7})$$

$$D3/D1 \leq 9.0 \quad (\text{Equation 8})$$

where the reference symbol D1 denotes an outside diameter of the electrode shaft, the reference symbol D2 denotes an outside diameter of the discharge member, and the reference symbol D3 denotes a length of the discharge member as measured in a direction of the electrode shaft.

Furthermore, it is preferable that the third or fourth embodiment has a spacing of 2 mm or shorter between the electrodes and satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0 \quad (\text{Equation 9})$$

$$D3/D1 \leq 9.0 \quad (\text{Equation 10})$$

where the reference symbol D1 denotes an outside diameter of the electrode shaft, the reference symbol D2 denotes an outside diameter of the cylindrical conductor, and the reference symbol D3 denotes a length of the cylindrical conductor as measured in a direction of the electrode shaft.

Since D1 is approximately determined depending on a value of a current to be supplied to electrodes in any case, a form of a discharge member can be selected optimum to improve a starting property.

Furthermore, a metalhalide can be enclosed as a discharge medium other than mercury and the rare gas in the first through fourth embodiments.

A discharge lamp may be ignited with a DC current or an AC current. For comparison with performance of the conventional discharge lamp, ignition with an AC current provides higher effects for a starting property and an arc stability. At the time of lighting with a DC current, a polarity of an input voltage is to be reversed depending on a lighting time and the number of lightings. Symmetry of a light emitting area can be improved and a service life of a lamp can be prolonged by reversing the polarity, for example, at intervals of 100 hours so that deterioration of only one electrode is not accelerated.

Furthermore, it is more preferable in the first through fifth embodiments that tungsten used as the material for the electrodes has smaller contents of impurities such as potassium, silicon and aluminium. These impurities hinder the halogen cycle due to reactions with halogens such as bromine, thereby shortening a service life of the lamps. Furthermore, large contents of the impurities lower a fuse point of tungsten, thereby making the lamps liable to be deteriorated. It is therefore preferable that a content of each impurity does not exceed 10 ppm.

A material other than pure tungsten may be selected for the electrodes. A doping agent such as thorium, for example, may be added to tungsten to improve a starting property of the lamp.

The heat dissipating conductor may not be limited to be a form of a coil. The heat dissipating conductor may, for example, be a cylindrical metal conductor surrounding the electrode shaft which has similarly enhance a heat dissipating property of the electrode shaft.

The heat dissipating conductor may be in contact or not in contact with the discharge member. Favorable starting performance can be obtained when the electrode is completely separate from the heat dissipating conductor.

Different materials may be selected for a main electrode and the heat dissipating conductor. Taking a starting property, a heat dissipating property, workability, etc. into consideration, materials optimum for a purpose of use are to be selected, for example, pure tungsten having an extremely high fuse point for the main electrode and tungsten containing a doping agent such as potassium relatively in a large amount for the heat dissipating conductor to facilitate to form a coil.

Though the discharge lamp which has a symmetrical form has been described above, the sealing members and the metal foils may be different in lengths, and the pair of electrodes may be disposed at locations deviated in any direction.

FIG. 10 exemplifies a configuration of a first embodiment of the light source apparatus according to the present invention. In FIG. 10, a reference numeral **131** denotes a lamp, a reference numeral **132** denotes a concave reflector, and a reference numeral **133** denotes a light source according to the present invention.

The lamp **131** is the same as the discharge lamp shown in FIG. 1a and comprises a base **135** fitted over a sealing member **134**. The base **135** is fixed with a heat-resistant adhesive agent **136** filled in a gap between the base **135** and the sealing member **134**. The sealing member **134** over which the base **135** is fitted is inserted into a lamp insert hole **137** of the concave reflector **132** and fixed with the heat-resistant adhesive agent **136**.

Used as the concave reflector **132** is a parabolic mirror or an ellipsoidal mirror. Formed on an inside surface of the concave reflector **132** is a reflective coating **138** comprising of a multi-layer film of a dielectric which reflects rays emitted from the lamp **131** in a predetermined direction at high reflectance. The concave reflector **132** has a large solid angle relative to a light emitting area of the lamp **131** and provides a merit to enhance a condensing ratio.

An extension conductor **139** has an end connected to an external conductor **140** and the other end which is taken out of the concave reflector **132** through a conductor outlet hole **141** of the concave reflector **132**. The lamp **131** can be started by applying a predetermined voltage across the extension conductor **139** and an external conductor **142**.

Since the lamp **131** has a high arc stability as described above, it can provide a stable illuminating luminous flux which scarcely flickers and is stable in brightness.



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Similar effects can be obtained using the discharge lamp according to the present invention as shown in FIGS. 2a, 4a, 7a and 8a.

The configuration according to the present invention makes it possible, by using the discharge lamp according to the present invention, to obtain a light source apparatus which integrates the discharge lamp with a concave reflector, and is favorable in a starting property and forms an illuminating luminous flux stable in brightness.

FIG. 11 exemplifies a configuration of a second embodiment of the light source apparatus according to the present invention. In FIG. 11, a reference numeral 151 denotes a lamp, a reference numeral 152 denotes a concave reflector, a reference numeral 153 denotes a front glass plate, and a reference numeral 154 denotes a light source apparatus according to the present invention.

The lamp 151 has a configuration which is the same as that of the discharge lamp shown in FIG. 2a. Used as the concave reflector 152 is an ellipsoidal mirror or a parabolic mirror. The lamp 151 is disposed so that a side over which a base 162 is fitted is inserted into a lamp insert hole 163, and a center of a light emitting area formed between electrodes 155 and 156 is approximately coincident with a first focal point 157 of the concave reflector, and fixed with a heat-resistant adhesive agent 158.

The front glass plate 153 is made of pyrex glass which is excellent in heat resistance and light transmittance, and fixed to an emitting side opening of the concave reflector 152 with a silicon series adhesive agent 159. A coating 160 which reflects ultraviolet rays and transmits visible rays is disposed on a surface of incidence of the front glass plate 153 to prevent detrimental ultraviolet rays out of rays emitted from the lamp 151 from leaking outside. Since a space which is substantially enclosed is formed in the concave reflector by attaching the front glass plate 153 to the emitting side opening of the concave reflector 152, broken pieces of the lamp 151 do not splash outside should the lamp be broken, thereby enhancing security of a light source apparatus 154.

A reflective coating 161 composed of a multi-layer film of a dielectric is formed on an inside surface of the concave reflector 152. Let us assume that a reference symbol  $\alpha$  denotes a range of condensation for rays which are emitted from a center of a light emitting area of the lamp 151, concretely a center between the electrodes 155 and 156, and incident on an effective reflecting surface of the concave reflector 152. Since tips of the electrodes 155 and 156 are tapered, rays emitted from the lamp 151 are not intercepted by the electrode 155 and 156 within the range of condensation  $\alpha$ . Accordingly, the light source apparatus 154 provides merit to effectively utilize the rays emitted from the lamp 151, thereby there is an advantage of enhancing an efficiency to utilize the rays.

Since the range of condensation  $\alpha$  is different depending on the form of the concave reflector 152, a taper angle  $\theta$  and a tip diameter  $\phi$  of the electrodes 155 and 156 are selected adequately so as to satisfy the Equation 2.

Similar effects can be obtained by using the discharge lamp shown in FIG. 7a or 8a as the lamp 151. In such a case, a form of the electrodes is to be determined so as to satisfy the mathematical formulae 3 and 4 or 5 and 6.

As described above, the configuration according to the present invention makes it possible, by using the discharge lamp according to the present invention, to obtain a light source apparatus which integrates the discharge lamp with a concave reflector, and is favorable in a starting property, forms an illuminating luminous flux stable in brightness and utilizes rays with a high efficiency.

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FIG. 12 exemplifies a configuration of a third embodiment of the light source apparatus according to the present invention. In FIG. 12, a reference numeral 170 denotes a discharge lamp and a reference numeral 181 denotes a concave reflector.

The discharge lamp 170 is disposed and adjusted so that a sealing member 171 to which a short metal foil 173 is sealed is inserted into an insert hole 182 of the concave reflector 181 and a focal point 187 of the concave reflector 181 is approximately coincident with a center between electrodes 175 and 176 of the lamp 170, and fixed with an adhesive agent 185. Used as the adhesive agent 185 is an inorganic heat-resistant adhesive agent such as Sumiserum or the like.

An extension conductor 186 has an end connected to an external conductor 178 of the discharge lamp 170 and the other end which is pulled outside through a conductor outlet hole 183 of the concave reflector 181. A gap between the conductor outlet hole 183 and the extension conductor 186 is filled with the adhesive agent 185.

Arc discharge is generated between the electrodes 175 and 176 by applying a predetermined voltage to the extension conductor 186 and an external conductor 177, and thereby mercury (Hg) 170a which is a discharge medium evaporates, and the light generation peculiar to the mercury 170a can be obtained.

The concave reflector 181 has an ellipsoidal surface and mirror has a first focal point F1 at a distance of 15 mm and a second focal point F2 (not shown) at a distance of 140 mm. The ellipsoidal surface generally has two axes of ellipse (a major axis and a minor axis). Lengths of the major and minor axes can be expressed by the following formulae respectively.

$$\text{Length of major axis} = F1 + F2 \quad (\text{Equation 11})$$

$$\text{Length of minor axis} = 2 \times (F1 \times F2)^{1/2} \quad (\text{Equation 12})$$

An axis of ellipse which contains the first focal point F1 and the second focal point F2 is the major axis, and an axis of ellipse which is perpendicular to the major axis is the minor axis. An ellipsoidal mirror shown in FIG. 12 has a major axis and a minor axis which are 155 mm long and 91.7 mm long respectively. When a metal foil 174 is too long in the ellipsoidal mirror, the foil is located close to the second focal point at which rays are condensed and raised to a high temperature. Therefore, a length is selected for the metal foil 174 so that a distance as measured from a vertex of the ellipsoid on a side of the lamp insert hole 182 to an end of the long metal foil 174 on a side of the opening of the concave reflector does not exceed  $\frac{1}{2}$  of the length of the major axis of the ellipsoidal surface.

An inside surface of the concave reflector 181 has a reflective coating 184 made of a multi-layer film of a dielectric and efficiently reflects rays which are emitted from between the electrodes 175 and 176 of the discharge lamp 170.

Though the concave reflector is not limited to the ellipsoidal mirror and may be a parabolic mirror or the like, the ellipsoidal mirror can provide a higher condensing ratio since it can have a larger solid angle relative to a light emitting area of the lamp.

The configuration shown in FIG. 12 wherein the sealing member 171 to which the short metal foil 173 of the discharge lamp 170 is sealed is fixed in the insert hole 182 of the concave reflector shortens a protruding length of the lamp rearward from the insert hole 182, thereby permits configuring the light source apparatus compact. The sealing

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member 171 can have a sufficient thermal capacity and a sufficient surface area since it is kept in contact with the concave reflector 181. Accordingly, the sealing member 171 is capable of suppressing temperature rise due to heat conduction from the light emitting bulb 170 and cannot be broken even when the short metal foil 173 is sealed in the sealing member 171. On the other, the sealing member 172 on the side of the opening of the concave reflector cannot be broken due to oxidation since the metal foil 174 which is longer than the metal foil 173, or has a sufficient length, is connected to the sealing member 172.

The discharge lamp 170 may comprise a base fitted over the sealing member 171.

As described above, the configuration according to the present invention makes it possible to compose a light source apparatus which is highly reliable and compact by fixing a sealing member in which a short metal foil of a discharge lamp is sealed to a concave reflector.

FIG. 13 exemplifies a configuration of a fourth embodiment of the light source apparatus according to the present invention. In FIG. 13, a reference numeral 191 denotes a front glass plate used as enclosing means, a reference numeral 192 denotes nitrogen gas and other components of the fourth embodiment are the same as those shown in FIG. 12.

The front glass plate 191 is made of pyrex which is excellent in thermal resistance and relatively inexpensive, and fixed to an opening of the concave reflector 181 on a side of emitting reflected rays with an adhesive agent 193 such as a silicon resin or the like. The front glass plate 191 formed an enclosed space inside the concave reflector 181, thereby preventing broken pieces from splashing outside even if the discharge lamp is broken while it stays lit.

It is preferable to form a reflective coating which eliminates ultraviolet rays and infrared rays on at least either of planar surfaces of the front glass plate 191 on a side of incidence or emitting rays. The reflective coating is capable of preventing ultraviolet rays and infrared rays from emitting outside. Furthermore, rays emitted from the discharge lamp 170 are allowed to emerge efficiently when an antireflection coating is formed on at least either of the planar surfaces.

The nitrogen gas 192 is enclosed in the enclosed space formed inside the concave reflector 181. The nitrogen gas 192 can be enclosed, for example, by cementing the front glass plate 191 to the concave reflector 181 in a glove compartment after the discharge lamp 170 has been fixed. An inert gas such as argon gas may be used in place of the nitrogen gas 192.

The configuration shown in FIG. 13 wherein the nitrogen gas 192 is enclosed in the enclosed space formed inside the concave reflector 181 is capable of preventing oxidation of the metal foil 174 disposed on the side of the opening of the concave reflector 181.

The concave reflector 181 may be a parabolic mirror or an ellipsoidal mirror: the ellipsoidal mirror which can have a large solid angle relative to a light emitting area of the lamp being capable of enhancing a light condensing ratio. Furthermore, the ellipsoidal mirror permits the concave reflector 181 to have a large depth in a direction of an optical axis and is suited to form an enclosed structure by disposing the front glass plate 191.

The discharge lamp 170 may comprise a base which is fitted over the sealing member 171.

Though the discharge lamp uses the metal foils which have different lengths in the fourth embodiment, the effects described above can be obtained irrespective of the lengths of the metal foils.

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The configuration according to the present invention makes it possible to prevent metal foils from being oxidized and compose a highly reliable light source apparatus by forming the enclosed space inside the concave reflector 181 with the front glass plate 191 and enclosing an inert gas such as the nitrogen gas 192 in the enclosed space.

FIG. 14 exemplifies a configuration of a fifth embodiment of the light source apparatus according to the present invention. In FIG. 14, a reference numeral 201 denotes argon gas and other components of the fifth embodiment are the same as those of the embodiment shown in FIG. 13.

Different from the embodiment shown in FIG. 13, the fifth embodiment uses the argon gas 201 which is enclosed at a pressure of 30 atmospheric pressures in an enclosed space in the concave reflector 181. Generally speaking, a light emitting bulb of a discharge lamp is hazardous to be broken since a pressure in the light emitting bulb is extremely high and largely different from an external pressure while the discharge lamp stays lit.

The configuration shown in FIG. 14 allows an internal pressure of the emitting bulb to reach to a level on the order of 10 MPas (mega pascals) during ignition of the discharge lamp 170, but the argon gas 201 enclosed at the pressure of 30 atmospheric pressures in the enclosed space reduces a difference between the internal pressure of the light emitting bulb and an external pressure, thereby remarkably moderating a breaking hazard of the light emitting bulb. Furthermore, the fifth embodiment provides, like the embodiment shown in FIG. 13, an effect to prevent oxidation of the metal foil 174 with the argon gas, thereby preventing the metal foil from being broken due to oxidation and enhancing reliability of the light source apparatus.

The concave reflector 181 may be an ellipsoidal mirror or a parabolic mirror: the ellipsoidal mirror which can have a large solid angle relative to a light emitting area of the lamp being capable of enhancing a light condensing ratio. Furthermore, the ellipsoidal mirror permits the concave reflector 181 having a large depth in a direction of an optical axis and is suited to form an enclosed space by disposing the front glass plate 191.

An inert gas such as nitrogen gas may be enclosed at a predetermined pressure in place of argon gas to obtain a similar effect. Furthermore, the breaking hazard of the light emitting bulb can be remarkably moderated by enclosing air at a predetermined pressure though it does not provide the effect to prevent oxidation.

A gas may be enclosed at a predetermined pressure which is not lower than 1 atmospheric pressure and not higher than an internal pressure of the light emitting bulb during ignition of the discharge lamp.

The discharge lamp 170 may comprise a base which is fitted over the sealing member 171.

The effect described above can be obtained irrespective of lengths of the metal foils though the fifth embodiment uses the metal foils having different length as the discharge lamp.

The configuration according to the present invention is capable of preventing the light emitting bulb from being broken and permits composing a highly reliable light source apparatus by forming an enclosed space in a concave reflector using a front glass plate and enclosing a gas into a light emitting bulb at a pressure not lower than 1 atmospheric pressure and not higher than an internal pressure of the light emitting bulb during ignition of a lamp.

FIG. 15 exemplified a configuration of a sixth embodiment of the light source apparatus according to the present invention. In FIG. 15, a reference numeral 210 denotes a discharge lamp and a reference numeral 221 denotes a concave reflector.

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The discharge lamp **210** is an ultra high pressure mercury vapor lamp to be ignited with an AC current and has a working pressure not lower than 10 MPas (mega pascals) during ignition. Therefore, a front glass plate is attached to an opening of a concave reflector to prevent glass pieces from splashing when the lamp is broken. The discharge lamp **210** has a position which is adjusted to insert a sealing member **211** in which a short metal foil **213** is sealed into an insert hole **222** of a concave reflector **221** and coincide a first focal point **227** of the concave reflector **221** approximately with a center between electrodes **215** and **216** of the lamp **210**, and is fixed with an adhesive agent **225**. Used as the adhesive agent **225** is an inorganic heat-resistant adhesive agent such as Sumiserum or the like.

An extension conductor **226** has an end connected to an external conductor **218** of the discharge lamp **210** and the other end pulled outside through a conductor outlet hole **223** of the concave reflector **221**. A gap between the conductor outlet hole **223** and the extension conductor **226** is filled with the adhesive agent **225**.

Mercury **210a** can be evaporated to emit its characteristic rays by applying a predetermined voltage across the extension conductor **226** and the external conductor **217** to cause arc discharge between the electrodes **215** and **216**.

The concave reflector is an ellipsoidal mirror as in the third embodiment (FIG. 12) described above, and a metal foil **214** has a length which is selected so that a distance as measured from a vertex of an ellipsoid on a side of the lamp insert hole **222** to an end of the metal foil **214** on a side of the opening does not exceed  $\frac{1}{2}$  of a length of a major axis of the concave reflector.

An inside surface of the concave reflector **221** has a reflective coating **224** made of a multi-layer film of a dielectric and efficiently reflects in a predetermined direction rays which are emitted from between the electrodes **215** and **216** of the discharge lamp **210**.

The configuration shown in FIG. 15 wherein the sealing member **211** in which the short metal foil **213** is sealed is fixed in the insert hole **222** of the concave reflector **221** shortens a rearward protruding length of the lamp from the insert hole **222**, thereby making it possible to configure the light source apparatus compact. The sealing member **211** can have a sufficient thermal capacity and a sufficient surface area since it is kept in contact with the concave reflector **221**. Accordingly, the sealing member is capable of suppressing temperature rise due to heat conduction from a light emitting bulb and preventing the short metal foil **213** from being broken due to oxidation even when the foil is sealed in the sealing member. When a front glass plate **231** is attached to an opening of the concave reflector **221**, on the other hand, an internal temperature of the concave reflector **221** is higher than that in a case where the front glass plate **231** is not attached and the metal foil **214** is heated to a higher temperature, but the sealing member **212** on the side of the opening of the concave reflector cannot be broken since the metal foil **214** which is sufficiently longer than the metal foil **213** is connected to the sealing member **212**.

The concave reflector **221** is not limited to the ellipsoidal mirror and may be a parabolic mirror, but the ellipsoidal mirror can have a larger solid angle relative to a light emitting area of the lamp and provides a higher light condensing ratio. Furthermore, the ellipsoidal mirror **221** permits the concave reflector having a larger depth in a direction of an optical axis and is suited to form an enclosed structure by disposing the front glass plate.

It is extremely effective for compact configuration of the light source apparatus to configure the metal foil **213** on a

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side of the lamp insert hole **222** of the concave reflector **221** shorter than the metal foil **214** on a side of the opening.

An interior of the concave reflector may not be enclosed completely, but a vent hole may be formed in a portion of the concave reflector or the front glass plate to cool the discharge lamp and the concave reflector.

The discharge lamp **210** may comprise a base or the like fitted over the sealing member **211**.

The configuration according to the present invention makes it possible to compose a highly reliable and compact light source apparatus by fixing the sealing member in which the short metal foil of the discharge lamp to the concave reflector as described above.

FIG. 16 exemplifies a configuration of the projection display apparatus according to the present invention. In FIG. 16, a reference numeral **240** denotes a light source, a reference numeral **241** denotes a UV-IR cut filter, a reference numeral **242** denotes a field lens, a reference numeral **243** denotes a liquid crystal panel and a reference numeral **244** denotes a projector lens.

The light source **240** is the same as the light source apparatus shown in FIG. 15 and a concrete configuration of the light source will not be described in particular.

After ultraviolet rays and infrared rays have been eliminated from rays emitted from the light source **240** by the UV-IR cut filter **241**, the rays transmit through the field lens **242** and are incident on the liquid crystal panel **243**. The field lens **242** condenses rays to illuminate the liquid crystal panel **243** onto the projector lens **244**. The liquid crystal panel **243** modulates the incident rays according to video signals and forms an optical image on the liquid crystal panel **243**. Rays transmitting through the liquid crystal panel **243** are incident onto the projector lens **244**, which magnifies and projects the optical image on the liquid crystal panel onto a screen (not shown).

The configuration shown in FIG. 16 which uses the light source apparatus shown in FIG. 15 as the light source **240** is capable of enhancing a reliability of the projection display apparatus and permits configuring the apparatus compact.

Though the embodiment is described as an example wherein the light source apparatus shown in FIG. 15 is used as the light source **240**, the light source apparatuses shown in any of FIGS. 10 through 14 can also provide effects to enhance a reliability of a projection display apparatus and configure the apparatus compact. The light source apparatus shown in FIG. 11, in particular, compact can efficiently condense rays emitted from the lamp, thereby enhancing luminance on a projection display apparatus.

An optical element, for example, a lens array or a polarized light converter element which leads the rays emitted from the light source **240** efficiently or uniformly to the liquid crystal panel **243** may be disposed between the light source **240** and the field lens **242**.

Though the embodiment is described above as an example wherein only one transmission type liquid crystal panel is used as a spatial light modulator element, it is possible to use, for example, three transmission type liquid crystal panels, a liquid crystal panel which utilizes scattering or a spatial light modulator element which forms an optical image as variations of refraction or reflection according to the video signals. A projection display apparatus can provide similar effects so far as the apparatus forms an optical image by modulating rays emitted from a light source.

Furthermore, a back projection type projection display apparatus can be configured by using a transmission type screen.

As understood from the foregoing description, the present invention makes it possible to configure, by using the light

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source apparatus according to the present invention as a light source, a compact and bright projection display apparatus which illuminates a spatial light modulator element such as a liquid crystal panel with the light source and projects an optical image on the spatial light modulator element.

What is claimed is:

1. A discharge lamp comprising:

a light emitting bulb having two ends;

a sealing member located at each of said two ends of said light emitting bulb;

a pair of electrodes, one of which is sealed in each of said sealing members and located in said light emitting bulb opposing each other at a predetermined spacing; and

a discharge medium enclosed in said light emitting bulb, wherein each of said electrodes comprises an electrode shaft and a discharge member integral with a tip of said electrode shaft and having an outside diameter larger than that of said electrode shaft, said discharge member having a taper formed on its tip, said electrode having a heat dissipating conductor located at an end opposite said discharge member and surrounding the electrode shaft, and

wherein said discharge lamp satisfies the following conditions:

$$\phi/L \leq 0.6$$

$$20^\circ \leq \theta \leq 60^\circ$$

where the reference symbol L denotes a spacing between said electrodes located in said light emitting bulb, the reference symbol  $\phi$  denotes a diameter of the tip of the discharge member, and the reference symbol  $\theta$  denotes an angle between said taper and said electrode shaft.

2. The discharge lamp according to claim 1, wherein said heat dissipating conductor is a coil.

3. The discharge lamp according to claim 1, wherein said electrodes and said heat dissipating conductor are made of different materials.

4. The discharge lamp according to claim 1, wherein said electrodes are made of tungsten doped with thorium.

5. The discharge lamp according to claim 1, wherein said discharge medium is mercury and a rare gas.

6. The discharge lamp according to claim 1, wherein said discharge lamp is for being lit by applying an AC voltage across said electrodes.

7. The discharge lamp according to claim 1, wherein said discharge lamp for being lit by applying an AC voltage across the electrodes, and a polarity of the voltage is reversed depending on the duration of time and number of times the lamp is lit.

8. The discharge lamp according to claim 1, wherein said electrodes are made of tungsten having a content of at least one of potassium, silicon and aluminum which does not exceed 10 ppm.

9. A light source apparatus comprising:

the discharge lamp according to claim 1; and

a concave reflector which reflects rays emitted from said discharge lamp in a predetermined direction.

10. A projection display apparatus comprising:

a light source;

a spatial light modulator element which is illuminated by said light source and forms an optical image according to video signals; and

projector means which projects the optical image formed on said spatial light modulator means on a screen,

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wherein said light source is the light source apparatus according to claim 9.

11. A light source apparatus comprising:

the discharge lamp according to claim 1; and

a concave reflector which reflects rays emitted from said discharge lamp in a predetermined direction,

wherein said concave reflector has an opening through which the reflected rays are emitted and a lamp insert hole located on a side opposite to said opening,

wherein said discharge lamp is located so that an end of said discharge lamp is located in said lamp insert hole and a center of a light emitting area formed between a pair of electrodes is approximately coincident with a shorter focal point of said concave reflector, and

wherein rays which are emitted from the center of said light emitting area and incident on an effective reflecting surface of said concave reflector are not intercepted by the electrodes of said discharge lamp.

12. A projection display apparatus comprising:

a light source;

an image forming means which is illuminated by said light source and forms an optical image according to video signals; and

a projector means which projects the optical image formed on said image forming means on a screen,

wherein said light source is the light source apparatus according to claim 11.

13. A discharge lamp comprising:

a light emitting bulb having two ends;

a sealing member located at each of said ends of said light emitting bulb;

a pair of electrodes, one of which is sealed in each of said sealing members and located in said light emitting bulb opposing the other at a predetermined spacing; and

a discharge medium enclosed in said light emitting bulb, wherein each of said electrodes comprises an electrode shaft, a cylindrical conductor which is located over a tip of said electrode shaft and has a tapered surface located on an outer circumference on a side of the tip of said electrode, and a heat dissipating conductor which is located at the rear of said cylindrical conductor and surrounding said electrode shaft, and

wherein said discharge lamp satisfies the following conditions:

$$\phi/L \leq 0.6$$

$$20^\circ \leq \theta \leq 60^\circ$$

where the reference symbol L denotes a spacing between said electrodes located in said light emitting bulb, the reference symbol  $\phi$  denotes an outside diameter of an end surface of said cylindrical conductor which is near the tip of said electrode shaft, and the reference symbol  $\theta$  denotes an angle between said taper and said electrode shaft.

14. A discharge lamp comprising:

a light emitting bulb having two ends;

a sealing member located at each of said ends of said light emitting bulb;

a pair of electrodes, each electrode sealed in one of said sealing members and located in said light emitting bulb opposing each other at a predetermined spacing; and

mercury and a rare gas enclosed in said light emitting bulb,

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wherein said mercury is present in an amount of 150 mg/cc or more,

wherein each of said electrodes comprises an electrode shaft and a discharge member integral with a tip of said electrode shaft and having an outside diameter larger than that of said electrode shaft, said discharge member having a tapered surface located on its tip, said electrode having a heat dissipating conductor located at an end opposite said discharge member surrounding said electrode shaft, and

wherein said discharge lamp satisfies the following conditions:

$$\phi/L \leq 0.6$$

$$20^\circ \leq \theta \leq 60^\circ$$

where the reference symbol L denotes a spacing between said electrodes located in said light emitting bulb, the reference symbol  $\phi$  denotes a diameter of the tip of said discharge member, and the reference symbol  $\theta$  denotes an angle between said taper and said electrode shaft, such that said discharge lamp is lighted by applying an AC voltage across said electrodes.

15. A discharge lamp comprising:

a light emitting bulb having two ends;  
sealing members located at each of said ends of said light emitting bulb;

a pair of electrodes, each electrode sealed in one of said sealing members and located in said light emitting bulb opposing the other at a predetermined spacing; and  
a discharge medium enclosed in said light emitting bulb, wherein each of said electrodes comprises an electrode shaft and a cylindrical conductor located over a tip of said electrode shaft, and having a heat dissipating conductor which is located at an end opposite said cylindrical conductor and surrounding said electrode shaft,

wherein a tapered surface is located on an inside end portion of said cylindrical conductor which is distal from the tip of said electrode shaft.

16. The discharge lamp comprising:

a light emitting bulb having two ends;  
a sealing member located at each of said ends of said light emitting bulb;

a pair of electrodes, each electrode sealed in one of said sealing members and located in said light emitting bulb opposing the other at a predetermined spacing;

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a discharge medium enclosed in said light emitting bulb, wherein each of said electrodes comprises an electrode shaft and a discharge member integral with a tip of said electrode shaft and having an outside diameter larger than that of said electrode shaft, and a heat dissipating conductor located at an end opposite said discharge member and surrounding said electrode shaft,

wherein said electrodes are located at a spacing not exceeding 2 mm and said discharge lamp satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0$$

$$D3/D1 \leq 9.0$$

where the reference symbol D1 denotes an outside diameter of said electrode shaft, the reference symbol D2 denotes an outside diameter of said discharge member, and the reference symbol D3 denotes a length of said discharge member as measured in a direction of an electrode shaft.

17. The discharge lamp comprising:

a light emitting bulb having two ends;  
sealing members located at each of said ends of said light emitting bulb;

a pair of electrodes, each electrode sealed in one of said sealing members and located in said light emitting bulb opposing the other at a predetermined spacing; and

a discharge medium enclosed in said light emitting bulb, wherein each of said electrodes comprises an electrode shaft and a cylindrical conductor located over a tip of said electrode shaft, and having a heat dissipating conductor which is located at an end opposite said cylindrical conductor and surrounding said electrode shaft,

wherein said electrodes are located at a spacing not exceeding 2 mm and said discharge lamp satisfies the following conditions:

$$2.0 \leq D2/D1 \leq 5.0$$

$$D3/D2 \leq 9.0$$

where the reference symbol D1 denotes an outside diameter of the electrode shaft, the reference symbol D2 denotes an outside diameter of the cylindrical conductor, and the reference symbol D3 denotes a length of said cylindrical conductor as measured in a direction of an electrode shaft.

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