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.

Fig. 4.

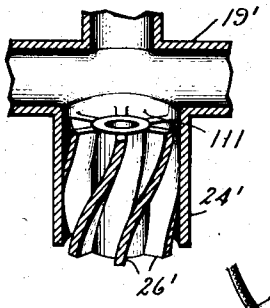



Fig. 1.

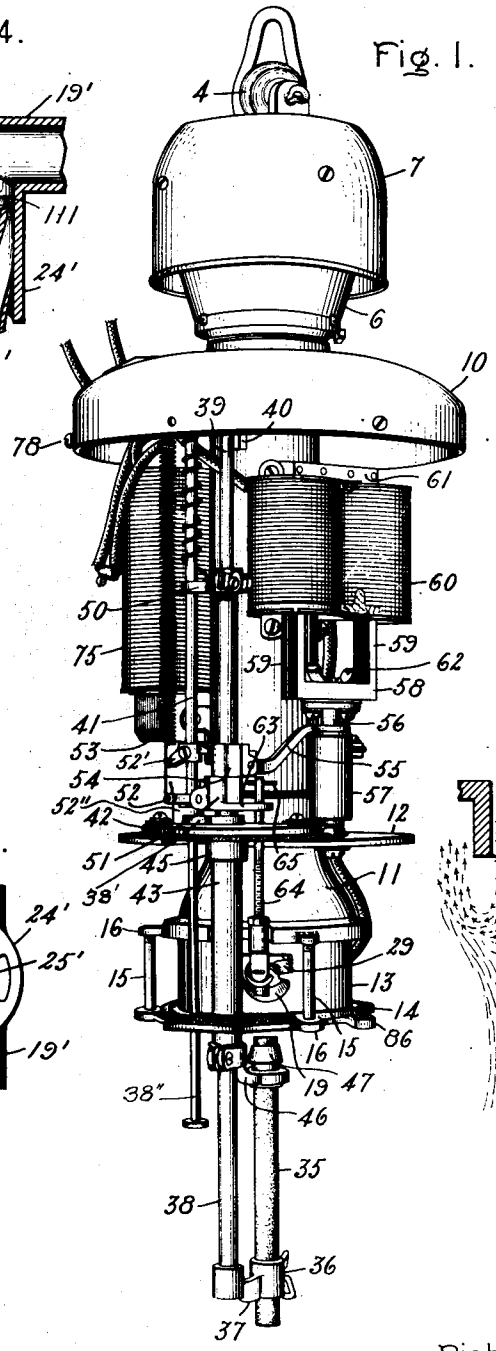



Fig. 2.

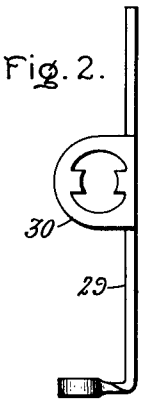



Fig. 3.

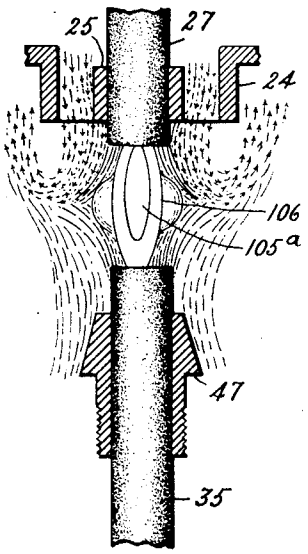
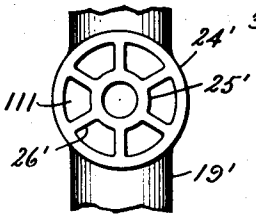



Fig. 5.




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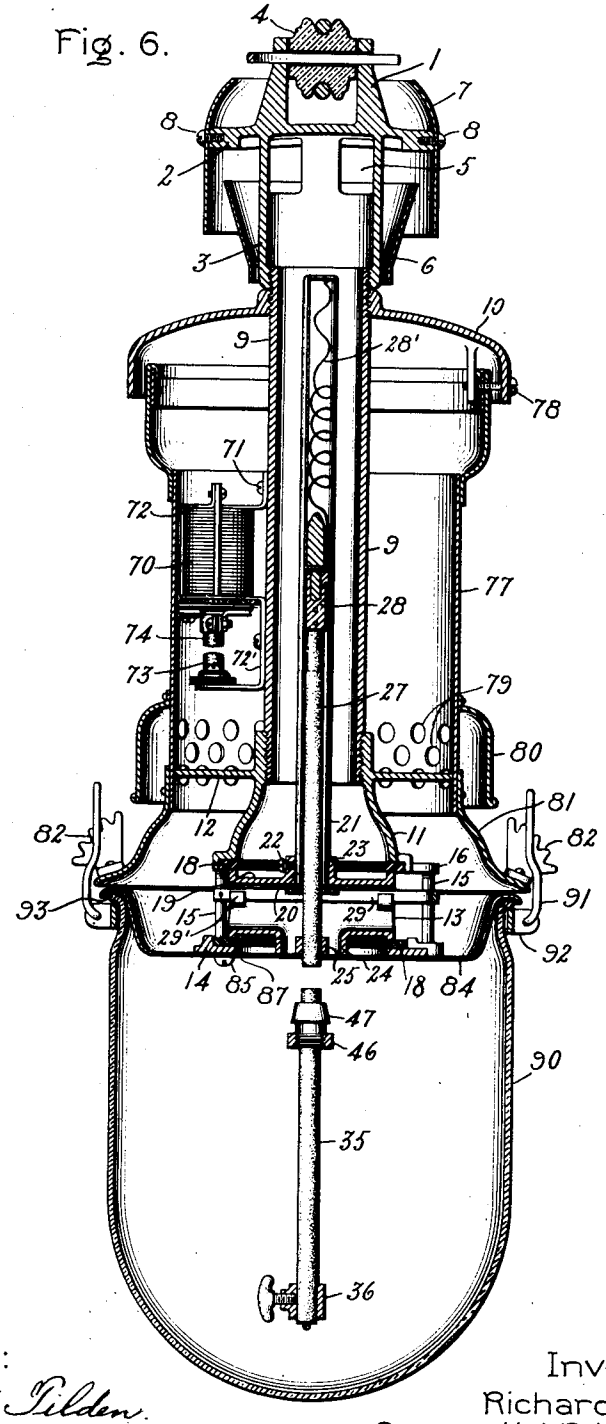
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3 SHEETS—SHEET 2.

Fig. 6.




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3 SHEETS—SHEET 3.

Fig. 7.

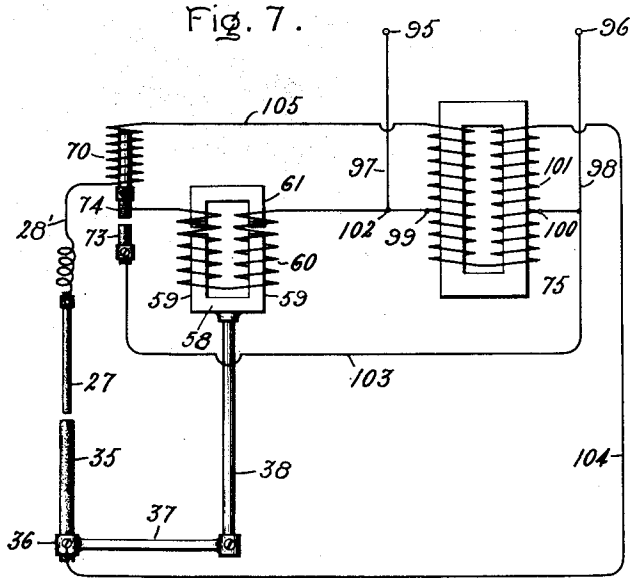



Fig. 8.

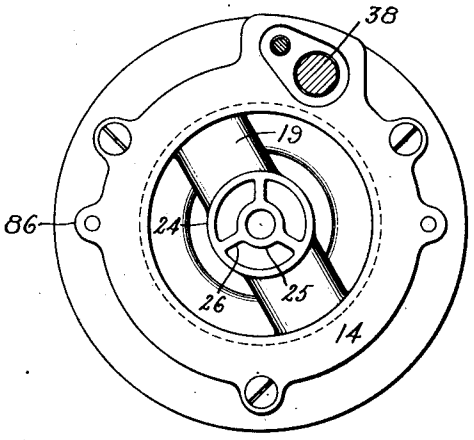
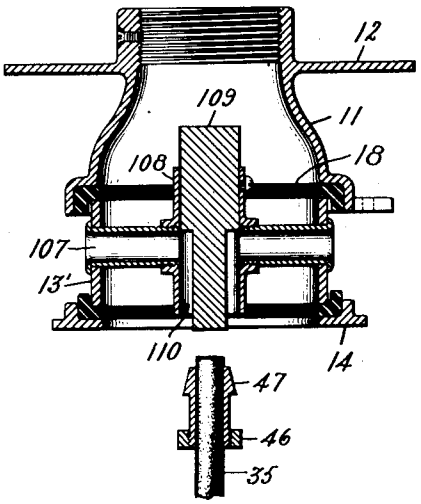



Fig. 9.




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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.

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 carbid 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 coöperating 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-

tive of an arc lamp with the casing and globe removed; Fig. 2 is a plan view showing one of the clutches employed in the lamp shown in Fig. 1; Fig. 3 is a diagrammatic representation of the arc and surrounding air currents; Fig. 4 is a perspective view with parts broken away and in section showing a modification; Fig. 5 is a plan view looking upward of the modification shown in Fig. 4; Fig. 6 is a sectional elevation of the lamp shown in Fig. 1 with parts removed to facilitate an understanding of the structure; Fig. 7 is a diagram showing circuit arrangements of the lamp of Fig. 1; Fig. 8 is an inverted plan view showing the lower end of the lamp structure proper of Fig. 1; and Fig. 9 is a sectional elevation showing a modified construction.

Referring to the construction illustrated in Figs. 1, 2, 3, 6, 7 and 8 of the drawings, 1 represents the hood or top member of the lamp. The hood or top member comprises a horizontal portion 2 from the lower end of which a tubular extension 3 projects. Means such as the pulley 4 of insulating material are carried from the upper side of the horizontal portion by which the lamp may be supported. The tubular extension has openings 5 formed in its upper end for a purpose hereinafter set forth. A shell 6 having its upper end flared is supported from the extension 3 in such manner that air currents may pass between its inner surface and the outer surface of the extension 3. The upper end of the shell 6 terminates slightly above the lower end of the aperture 5. A shell member 7 surrounds the horizontal portion 2 of the member 1 to which it is secured by screws 8.

The lower end of the tubular extension 3 is threaded internally and a tubular member or pipe section 9 externally threaded is screwed into the lower end of the extension 3. A dish-shaped hood 10 is secured to the upper end of the tubular member 9 just below the end of the extension 3, a threaded aperture being centrally formed in the member 10 in which the member 9 is screwed. The lower end of the member 9 which is externally threaded has screwed upon it an internally threaded hollow member 11. The member 11 is provided with a horizontally extending flange portion 12 which is circular in outline. The flange portion 12 forms the lower platform of the lamp.

Against the lower end of the lower portion of the member 11, which is bell shaped, is secured a chambered member 13. In the form illustrated in the drawing the outer surface of the member 13 is cylindrical, and the member is secured in place by means of an annular member 14 bearing against the lower end of the member 13 and secured to the lower end of the member 11 by screws or bolts 15 which are threaded into ears 16 formed on the member 11. Suitable means such as washers 18 formed of insulating material are employed to insulate the members 11 and 13 from each other. A tubular member or part 19 which may be formed integrally with the body 13 passes diametrically through the latter. The outer shell of the member 13 is apertured at the ends of the tubular part or member 19.

An opening 20 axially located with respect to the outer wall of the member 13, the member 11 and the member 9, is formed in the upper side of the member 19. An electrode casing or tube 21, which may be formed out of sheet metal, is axially placed in the members 9 and 11. The upper end of the tube is about on a level with the upper end of the member 9. The lower end of the tube 21 projects into the opening 20 and is secured in fixed relation to the part 19 by a screw 22 passing through a tubular boss 23 projecting from the upper side of the part 19. From the under side of the part 19 a cylindrical flange portion 24 concentric with the shell 21 projects downward. A ring or electrode guide portion 25 may if desired be connected to the flange 24 by ribs 26 though it is frequently dispensed with.

The upper electrode 27 of the lamp slides in the shell 21, which with the member 19 forms a receptacle for the electrode in which the body of the electrode is protected from the heated gases passing through the chimney. The upper end of the electrode 27 is secured in any suitable manner as by means of spring clips or the like to a follower weight 28 which in turn is connected to the upper and closed end of the shell or member 21 by a flexible conductor 28′. The lower end of the electrode 27 which projects out of the lower end of the shell 21 passes through the ring or guide 25. A clutch member 29 provided with an electrode engaging portion 30 is employed for intermittently securing the electrode 27 in fixed relation to the tube 21 as the conditions of service demand in a manner hereinafter described. The clutch 29 in the construction illustrated is located in the bore of the part 19 and has one edge supported by lugs 29′ from the part 19.

The lower electrode 35 of the lamp which is in axial alinement with the electrode 27 is secured at its lower end in a socket part 36 carried by a bracket 37 secured to he lower end of a tubular member 38 which extends parallel to the electrode. The tubular member 38 slides on a rod 39, the upper end of which is secured to a bracket 40 secured to but insulated from the upper d of the member 9 just below the hood ). A rod 41 parallel to the rod 39 has its u per end secured to the bracket 40 and its

lower end secured to a member 42 which is secured to but insulated from the flange 12.

A tubular member 43 having its upper end secured in a socket part 45 carried by the member 42 projects downward to a point below the lower end of the member 13. The tubular member 43 surrounds the member 38 and serves as a guide for it. To the lower end of the member 43 is detachably secured an arm 46. The outer end of the arm 46 is formed with a threaded aperture in which is screwed the lower end of a tubular shell or shield 47. This shield or member 47, which is formed of some good heat conducting material such as copper or brass, is formed with an aperture in which the electrode 35 has a sliding fit. The vertical position of the member 47 may be adjusted by screwing it up or down in the threaded socket in the arm 46.

A cross-head 50 is secured to the upper end of the member 38. The cross-head is formed with an aperture or slot through which the rod 41 passes. The cross-head can thus slide upon the rod 41 and serve to prevent angular displacement of the electrode 35 about the line of movement of the member 38. A flexible conductor is employed to electrically connect the bracket 40 and the cross-head 50.

Upper and lower clutches in coöperative relation with the member 38 are located above the flange or platform 12. The yoke member 51 of the lower clutch which surrounds the member 38 is provided with a pivoted pawl 52 normally held in position to lock the lower clutch to the member 38 by a helical spring 53. The lower end of the spring 53 is secured to the outer end of the pawl 52 while the upper end is secured to the bracket 40. The yoke member 54 of the upper clutch, which also surrounds the member 38, has pivoted to it a pawl 55. The outer end of the pawl 55 loosely surrounds a short neck or stem 56 which connects the upper end of the outer member of a dashpot 57 to the lower end of an armature 58. The armature 58, which is U-shaped, is provided with two similar upwardly extending legs 59. Each leg 59 passes axially into the corresponding one of a pair of vertically disposed magnet coils 60. The magnet coils 60 are secured in any suitable manner to the tubular member 9. In order to strengthen the action of the magnet coils upon the armature, a stationary U-shaped core 61 has its downwardly projecting ends extending into the upper ends of the coils 60. A bow-shaped spring 62 secured to the upper side of the yoke member of the armature 58 serves to prevent a violent engagement between the armature 58 and the lower ends of the coils 60 when energized in a manner hereinafter described.

An extension 63 from the yoke member 51 is formed with an aperture through which passes the upper end of a member 64 which is connected to the outer end of the clutch member 29. A cross pin 65 passing through the upper end of the rod 64 above the extension 63 serves as a means by which after a certain predetermined upward movement of the clutch yoke 51 further upward movement of the yoke will cause the member 64 to be lifted to cause the clutch 29 to release the electrode 27 and allow it to move downward under the action of its weight and that of the followers 28. In the position shown in Fig. 1 with the clutch member 51 down, there is no engagement between the extension 63 and the cross pin 65, and the clutch member 29 is held by its own weight and that of the member 64 in the position in which it locks the electrode 27 in fixed relation to the tube 21.

A solenoid magnet coil 70 with its axis vertically disposed is secured to the member 9 in any suitable manner as by means of screws 71 which pass through extensions from the end pieces 72 of the magnet. An outwardly turned portion from the extension of the lower end piece 72 forms a bracket 72′ upon which a contact piece 73 is supported. The contact piece 73, which may be in the form of a short section of a carbon pencil, is insulated from the bracket. A movable armature or core passes axially into the bore of the coil 70. The lower end of the armature carries a contact member 74 which may also be in the form of a section of carbon pencil. When the coil 70, which is in series with the arc between the electrodes 27 and 35, is not energized by the proper current, the contact member 74 engages and rests on the contact 73 but when the coil is operatively energized the contact 74 is held out of engagement with the contact member 73 as shown in Fig. 6 of the drawings.

The lamp construction shown in Figs. 1, 6, 7 and 8 is primarily intended for operation with alternating current. When the alternating current for operating the lamp comes from a constant current system we prefer to employ a compensator or auto-transformer 75 which is supported from the member 9 by brackets in any suitable manner. The casing 77 is hung from the hood member 10 in the usual manner as by screws 78. The lower end of the casing 77 closely embraces the periphery of the flange 12. This casing serves to protect the lamp mechanism located between the hood 10 and the platform 12. Suitable apertures 79 guarded by a shield 80 are provided for admitting air for ventilating purposes to the interior of the casing. An annular extension from the casing 77 is secured to the lower end of the latter. The lower end of the extension 81 which flares outward has secured to it

two toothed members 82. A disk-shaped member 84 is secured against the lower surface of the member 14 by screws 85, which are screwed into openings in ears 86 formed for the purpose on the member 14. The disk-shaped member 84 is formed with an aperture 87 which registers with the opening in the member 13. A globe 90 inclosing the electrode 35 is held against the under side of the outer edge of the member 84 by bails or hooks 91 carried by a collar 92 secured to the upper end of the globe 90. Each of the bails 91 hooks over one of the teeth on the corresponding toothed member 82. In order to get a tight joint between the upper end of the globe 90 and the member 84, a gasket or washer 93 of any suitable material may be employed.

In Fig. 7 we have shown a diagram of the circuit arrangement which we may employ in operating our lamp from a constant alternating current circuit. In the diagram 95 and 96 represent the lamp terminals which are connected into the external circuit. Conductors 97 and 98 connect the terminals 95 and 96 respectively to the points 99 and 100 in the winding 101 of the compensator 75. One terminal of the coils 60, which are connected in series with each other, is connected to the line 97 at the point 102. The other terminal of the coil 60 is connected to the contact member 74. The contact member 73 is connected to the conductor 98 by a conductor 103. One end of the effective portion of the winding 101 is connected to the electrode 35 by a conductor 104. The other end of the effective portion of the compensator winding is connected to one of the terminals of the winding of the magnet 70 by conductor 105. The other terminal of the winding of the coil 70 is connected to the electrode 27.

In the out-of-service condition of the lamp which is shown in Fig. 1, the coils 60 are deënergized and the armature 58 is in its lowest position, the electrodes 27 and 35 being separated. Similarly the winding of the coil 70 is deënergized and the contacts 73 and 74 are in engagement. On connecting the lamp in circuit current begins to flow through the circuit which includes the conductor 97, windings of the coil 60, contact members 74 and 73, conductor 103 and conductor 98. This causes the armature 58 to be elevated. The elevation of the armature 58 causes the electrode 35 to be raised through the action of the upper clutch on the tubular member 38. As the tubular member 38 is moved upward, the lower clutch member will, under action of the spring 53, move with it until the pawl 52 engages a stop 52′ adjustably secured to the rod 41 after which further upward movement of the member 38 will not produce a corresponding movement of the lower clutch member. As the lower clutch member approaches the upward limit of its movement the cross-pin 65 is engaged and the clutch member 29 operated to release the upper electrode which thereupon starts to fall into engagement with the lower electrode. When the electrodes 35 and 27 come together current begins to flow between them through a circuit which includes the entire compensator winding 101, conductor 105, winding of the coil 70, electrodes 27 and 35 and conductor 104. The passage of current through the coil 70 causes the armature to be raised, thus separating the contacts 74 and 73 and opening the circuit through the coils 60.

In the ordinary case in which the lower electrode has been consumed since the preceding feeding operation, the member 38 is pulled through the yoke 51 of the lower clutch member far enough at each feeding operation to compensate for the electrode consumption since the previous feeding operation before an operative contact is established between the two electrodes and sufficient current flows through the windings 70 to cause the separation of the contact members 73 and 74.

As soon as the circuit through the coil 60 is broken by the separation of the contact members 74 and 73 the electrode 35 begins to descend under the action of gravity thus drawing an arc between the two electrodes. The dashpot 57 is arranged so as to offer no resistance to the upward movement of the armature 58, but to prevent a rapid downward movement of the armature, thus insuring a separation of the electrodes slow enough to prevent a rupture of the arc. It will, of course, be understood that after a small initial downward movement of the electrode 35, the lower clutch holder moves out of engagement with the cross pin 65 and the upper electrode is locked in the tube 21 by the clutch member 29. The downward movement of the lower electrode is checked and the length of the arc struck limited by the engagement of the pawl 52 with a stop 52″ formed on the member 42. It will thus be observed that the length of the arc struck after each feeding operation is equal to the play of the pawl 52 between the upper and lower stops 52′ and 52″ respectively and is independent of the electrical condition of the lamp.

With the compensator connected as shown in Fig. 7, the voltage between the terminals 95 and 96 is, of course, materially less than the voltage of the arc and the currents in the primary and secondary windings of the compensator vary inversely. The use of the compensator in the manner described is of particular utility where one of the electrodes, for instance the upper one, is composed of or contains some material like

titanium carbid. With such an electrode the arc current is usually materially lower than that of the ordinary lamp giving the same light and using a carbon electrode though the arc voltage may be somewhat higher. The arrangement specified thus facilitates the employment of a lamp with a titanium carbid electrode in existing circuits.

Ordinarily after the arc is struck in the manner described the lamp operates without feeding until the upper electrode is consumed to such an extent that in the wandering of the arc, its upper end plays upon the ring 25. When this occurs rectification of the arc current begins to take place and the arc resistance becomes abnormally high. This either causes the arc to break or so reduce the current in the secondary winding of the compensator to such a value that the magnet coil 70 is no longer operatively energized. The contact members 73 and 74 then engage, closing the circuit through the coils 60 whereupon the feeding operation of the lamp is repeated.

As the air about the arc in the globe 90 becomes heated by the arc an ascending current is set up which passes through the draft tube or chimney formed of the member 13, member 11, member 9 and the projection 3 to the atmosphere through the apertures 5. It will be observed that the chimney thus formed is practically unimpeded and extends from the arc to the top of the lamp and is of the maximum length possible in a lamp of the given dimensions. The air moving out of the chamber or globe 90 by slow natural draft through the chimney is replaced by rapidly moving air entering the globe through the tubular member or portion 19. The flange member 24 and concentric ring 25 form an annular contracted nozzle through which the contracted entering air current passes downward along the lower end of the upper electrode and the arc extending therefrom in the form of an envelop, shell or tubular body of cool rapidly moving air. This moving body of air which has greater velocity than the upward current through the wide unimpeded chimney serves to centralize the arc particularly its upper end.

We prefer to proportion and arrange the parts so that the downwardly moving tubular body of air is deflected or spread outward at points above the upper end of the lower electrode as indicated by the arrows in Fig. 3 of the drawing. The main part of this outwardly deflected body of air is immediately drawn upward into the chimney, while the remainder apparently continues laterally beyond the entrance to the chimney toward the wall of the globe, where it descends and then again rises along the lower electrode. With this arrangement the general upward movement of air in the globe and chimney causes an upward movement of air by the upper end of the lower electrode, thus in effect creating an upwardly movable shell or envelop of air surrounding the upper end of the lower electrode. The general direction of this tube or shell of air is indicated by the upwardly pointed arrows in Fig. 3.

When the upper electrode is formed of titanium carbid and the lower electrode is formed of carbon, the arc includes a central highly luminous portion or part $105^a$ which extends from the lower end of the upper electrode toward but does not reach the lower electrode. By providing the downward draft of the upper electrode as described, the length of the highly luminous portion $105^a$ is materially lengthened. This is partly due to the fact that without such a downward draft the natural upward draft created by the arc has a tendency to fan out the lower luminous portion $105^a$ of the arc. This, of course, is overcome by the use of a downward draft. Moreover with the arrangement shown in the drawings a practically motionless body of hot gas 106 (see Fig. 3) is formed about the arc which increases the efficiency of the arc as a light-producing agent by increasing its temperature.

When the electrode containing the light-producing salt or salts is formed wholly or largely of titanium carbid a tendency to disintegration of the arcing end of the electrode is produced by the heat of the arc. By forcing a comparatively powerful draft of cool air by the arcing end of the electrode, as in the arrangement shown in the drawings, this tendency toward disintegration is practically done away with. So far as this feature of our invention is concerned it is immaterial whether the titanium carbid electrode is the upper electrode or the lower electrode of a lamp having vertical electrodes or is a horizontal electrode. The tendency to disintegration experienced with titanium carbid is also found in connection with electrodes formed of certain other materials giving flaming or luminous arcs.

The shield 47 serves to conduct away heat from the lower electrode and thereby reduces its consumption by heat oxidation. Its form and the form of its support 46 serve as a means for shaping the upward flow of air by the lower electrode. The flow of air relative to the upper end of the lower electrode may also be affected by the elevation of the shield 47 in its support.

To release the rod 38 from the clutch members in order to permit trimming of the lamp or for other purposes, a collar 38′ is placed about the rod 38 between the member 42 and the yoke of the lower clutch member. An operating rod 38″ connected

at its upper end to the collar 38′ extends downward through openings formed for the purpose in the members 42 and 14. By moving the operating rod 38″ upward the clutches will be forced up into the position in which the pawl of the lower clutch engages the upper stop 51 in which position the rod 38 is released from both clutches and may be lowered.

In the construction shown in Fig. 9 the member 13 is replaced by a member 13′ in the form of a cylindrical shell supported in the same manner as is the member 13. Pipe sections 107 are passed through openings formed for the purpose in the wall of the member 13′ and have their inner threaded ends screwed into radially extending bosses formed on a tubular vertically disposed member 108. The outer ends of the pipe sections 107 are expanded to form heads bearing against the outer surface of the wall of the member 13′. A bar 109, formed of suitable material such as wrought copper, is removably secured in the tubular member 108. As shown, the bar 109 is in axial alinement with the electrode 35 of the lamp. In the construction shown in the drawings, the lower end of the bar 109 is reduced beginning at a point in line with the upper sides of the openings in the pipe sections 107 and an annular space 110 is thus formed between the lower reduced portion of the bar 109 and the inner surface of the member 108. It will be understood that the construction shown in Fig. 9 is intended to be employed in a lamp substantially like that shown in Fig. 6 with means for producing a downward draft passing by the lower end of the copper bar 109, similar to the draft by the lower end of the electrode 27.

The bar 109 is intended to form a non-consuming positive electrode for a direct-current lamp. The arcing end of the bar 109 is usually somewhat larger in diameter than the upper end of the coöperating negative electrode. It should be large enough so that the bar will not be heated to a temperature at which rapid oxidation will occur, and should be small enough so that the under part of it will not cool to a point which will facilitate rapid condensation of arc products thereon. The downwardly flowing tubular shell of air about the arcing end of the electrode 109 prevents the accumulation on the side of the electrode of material condensed from the arc and keeps its temperature down to a safe point. By reason of the difference in diameter of the two electrodes of the character ordinarily used in the construction shown in Fig. 9, the practically motionless body of hot gas formed in the eddies created at the junction of the upwardly moving draft by the lower electrode and the downwardly moving air by the upper electrode is somewhat greater and extends higher up than with the arrangement shown in Figs. 1 and 6. This is an advantage where the lower electrode is the one from which the luminous arc portion $105^a$ extends. With electrodes such as those composed principally of oxids of iron and titanium which we ordinarily prefer to use with copper non-consuming positive electrodes the disadvantages from heating the arcing ends to a high temperature are not experienced as with titanium carbid electrodes and such electrodes may therefore be safely run at higher temperatures than titanium carbid electrodes without trouble from disintegration produced by heat.

We have sometimes obtained advantageous results by arranging a series of air induction pipes so that the air is discharged about the arcing end of the electrode with a movement which is not parallel to the axis of the arc, though in planes parallel thereto. One construction for obtaining this result is shown in Figs. 4 and 5 of the drawings where a number of passages 111, each so located or arranged that it discharges the air passing through it in a plane parallel to the axis of the arc, the line of movement being oblique to the axis of the arc. This gives a sort of a whirling movement to the air surrounding the arc.

In the construction shown in Figs. 4 and 5 a member 19′ substantially similar to the member 19 of the construction shown in Figs. 1, 6 and 8 is employed. The flange portion 24′ is elongated somewhat as is the ring portion 25′ which extends upward to the body portion of the member 19′. The ribs 26′ which connect the portions 24′ and 25′ extend spirally about the portion 25′ so that the passages 111 formed between each adjacent pair of ribs 26′ and the inner and outer walls respectively of the flange 24′ and the portion 25′ are spiral.

While in the preceding descriptive matter and in the drawings we have described and illustrated the best forms of our invention now known to us, it will be obvious to those skilled in the art that many changes may be made in the form of our invention without departing from its spirit, and we do not wish the claims hereinafter made to be limited by the embodiment shown and described more than is made necessary by the state of the art.

Features of our invention illustrated and described but not specifically claimed herein are claimed in our application Serial No. 296,304, filed January 16, 1906.

We do not claim herein the arrangement of the regulating mechanism as dependent for its operation upon the use of the compensator, as illustrated in Fig. 7; since this matter is the subject of a divisional application, Serial No. 774,685, filed June 19th 1913.

What we claim as new and desire to se-

cure by Letters Patent of the United States, is,

1. In an arc lamp, a draft tube, a chambered member in open communication therewith, inlet passages formed in said chamber and terminating in a contracted annular nozzle, an electrode, and means for supporting it with its arcing end adjacent the end of said nozzle.

2. In an arc lamp, a pair of electrodes in alinement with each other, means for maintaining an arc between adjacent ends of said electrodes, and means for creating a draft extending by the arcing end of each electrode toward the opposite electrode.

3. In an arc lamp, a pair of electrode surfaces between which an arc extends, one of said electrode surfaces being located above the other, and means for creating an air draft passing downward about the upper surface.

4. In an arc lamp, a central draft tube forming the backbone of the arc lamp structure, an electrode located in said draft tube and having its arcing end adjacent the lower end thereof, a second electrode in alinement with and below the first electrode, and means for creating a draft passing downward by the lower end of the upper electrode.

5. In an arc lamp, a draft tube or chimney through which gases heated in the lamp pass upward, an upper electrode having its arcing surface adjacent the lower end of the draft tube, and an air inlet passage surrounding the arcing end of said electrode for conveying air or gas downward by the arcing end of said electrode.

6. In an arc lamp, a pair of arcing surfaces, means for maintaining an arc between said surfaces, and means for causing a draft to pass by each arcing surface toward the other arcing surface.

7. Means for establishing an electric arc, and means for causing air currents to pass along each end of the arc toward the opposite end.

8. In combination, means for maintaining an electric arc, and means for causing each end of said arc to be surrounded by a shell of air moving toward the opposite end of the arc.

9. In combination, means for maintaining an electric arc, means for causing each end of said arc to be surrounded by a shell of air moving toward the opposite end of the arc, and means for rendering the speed of movement of one of the two bodies of air greater than that of the other.

10. Means for establishing an electric arc, and means for causing tubular bodies of air surrounding each end of the arc to flow toward the opposite end of the arc.

11. Means for establishing an electric arc, means for causing a body of air surrounding one end of the arc to move toward the opposite end of the arc, and means for causing a similar movement of a body of air surrounding said opposite end of the arc toward the first mentioned arc end.

12. In an arc lamp, an inclosing chamber, a chimney leading from the upper end thereof, a receptacle for the upper lamp electrode located in said chimney, said receptacle being provided with a conduit for conducting air from without the chimney into said receptacle and with an orifice through which said air is discharged downward by the lower end of the electrode contained in said receptacle, mechanism for controlling the position of the electrode contained in said receptacle, and operating means therefor located in said conduit.

13. In an arc lamp, an electrode, an annular member surrounding its arcing end, means including a conduit for causing air to flow through the space between said member and said electrode, a clutch for the electrode, and supporting means therefor located in said conduit.

14. In an arc lamp, a chimney, an electrode receptacle located therein, a conduit for conveying air into said receptacle from without said chimney, a clutch for said electrode, and supporting means therefor located in said conduit.

15. In an arc lamp, a pair of electrodes for maintaining an arc, and means for causing a shell of gas surrounding the arc to flow axially of the arc from the arcing end of each electrode toward the arcing end of the other.

16. In an arc lamp, a pair of electrodes arranged to maintain a vertical arc, a chimney above the arcing ends of the electrodes, a nozzle arranged to discharge a shell of air downward about the arc, and an arc-inclosing globe arranged to cause a shell of air to flow upward about the arc so as to meet the downwardly moving shell.

17. In an arc lamp, a pair of electrodes between which an arc is maintained, and means for causing a shell of gas surrounding the axis of the arc to flow from the arcing end of each electrode toward the arcing end of the other electrode.

18. In an arc lamp, a pair of electrodes arranged to maintain an arc having a vertical axis, a chimney above the arcing ends of the electrodes, a nozzle for discharging air downward about the arc, and means for causing an upward flow of air about the arc.

19. In an arc lamp, a pair of electrodes arranged to maintain a vertical arc, a chimney above the arcing ends of the electrodes, a nozzle within the chimney for directing a shell of air downward about the arc, and an arc-inclosing globe arranged to cause a shell of air to flow upwardly about the arc so as to meet the downwardly flowing shell.

20. In an arc lamp, a chimney member, a nozzle within the chimney member, a pair of electrodes arranged to maintain an arc in axial alinement with the nozzle, said nozzle opening into the atmosphere at one side of the lamp, and an arc-inclosing globe for causing currents of air to flow past the end of the arc remote from the nozzle and toward the nozzle.

21. In an arc lamp, the combination with electrodes and an inclosing casing therefor, of means for directing a draft toward the inner surface of the casing and for causing rotation of the atmosphere within the casing about an approximately vertical axis.

22. In an arc lamp, the combination with electrodes and an inclosing casing therefor, of means for causing a draft to enter the casing and to revolve about an approximately vertical axis.

23. In an arc lamp, a pair of electrode-surfaces between which an arc extends, one of said electrode-surfaces being located above the other, a chimney for drawing the products of combustion from the lamp, and means for inducing by the chimney draft an air draft passing downward about the upper electrode surface.

24. In an arc lamp, a pair of electrodes in vertical alinement and between which an arc extends, means for producing a draft for carrying the products of combustion from the lamp, and means for inducing by said draft an air current passing downward about the lower end of the upper electrode.

25. In an arc lamp, a pair of electrodes in vertical alinement and between which a vertical arc extends, means for producing a draft for carrying the products of combustion from the lamp, and means for producing by said draft an air current passing downward about the upper end of the arc.

26. In an arc lamp, the combination of the electrodes, means for creating a draft in the lamp comprising concentric tubes surrounding one of the electrodes, the drafts being directed toward the arc in the inner passage and away from it in the outer passage.

In witness whereof we have hereunto set our hands this third day of March, 1905.

RICHARD FLEMING.
CROMWELL A. B. HALVORSON, JR.

Witnesses:
ALEX. F. MACDONALD,
JOHN A. MCMANUS, Jr.