No. 785,516. PATENTED MAR. 21, 1905.

C. OLIVER.

ELECTRIC ARC LAMP.

APPLICATION FILED FEB. 29, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

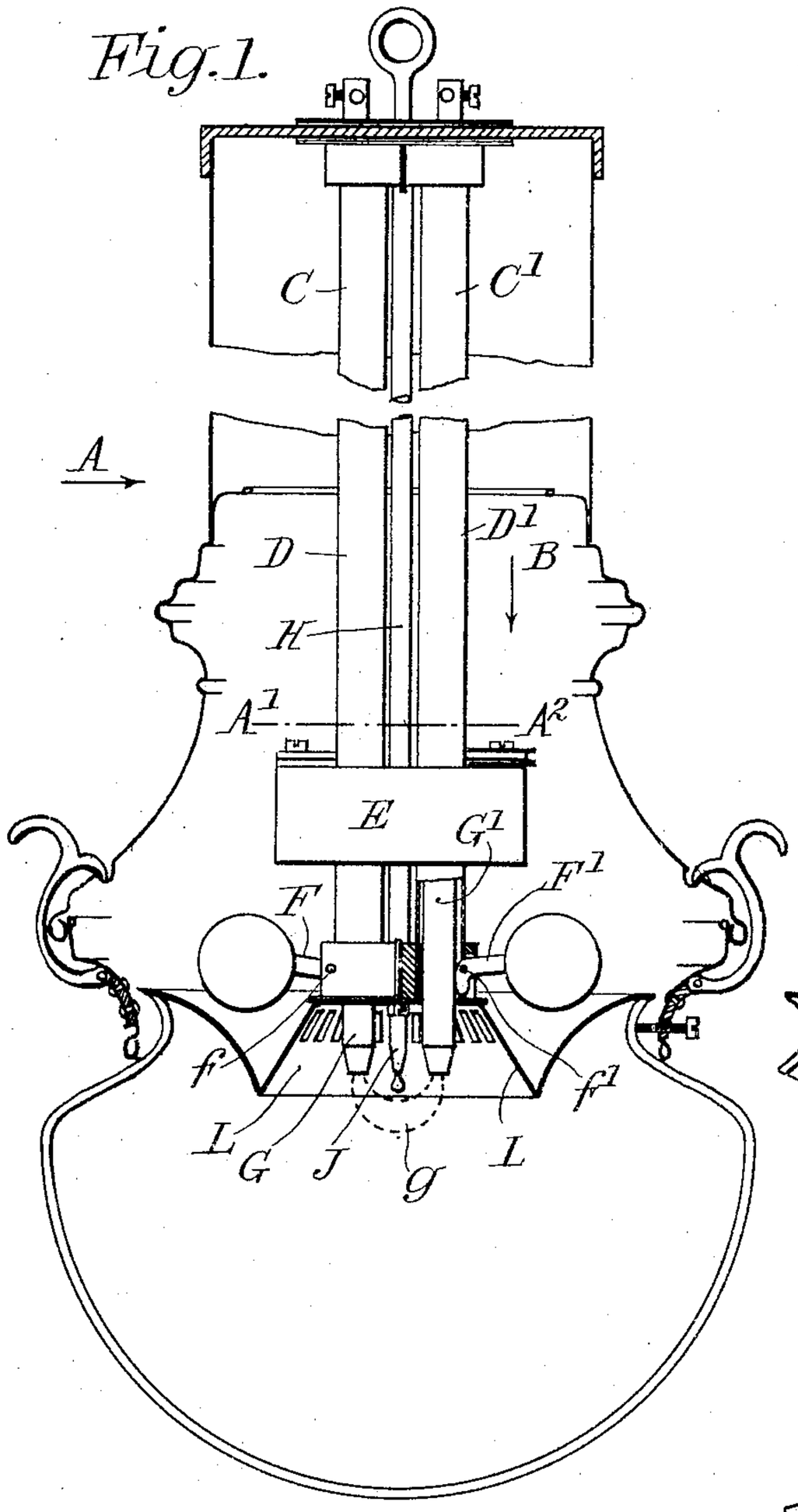

Fig. 2.

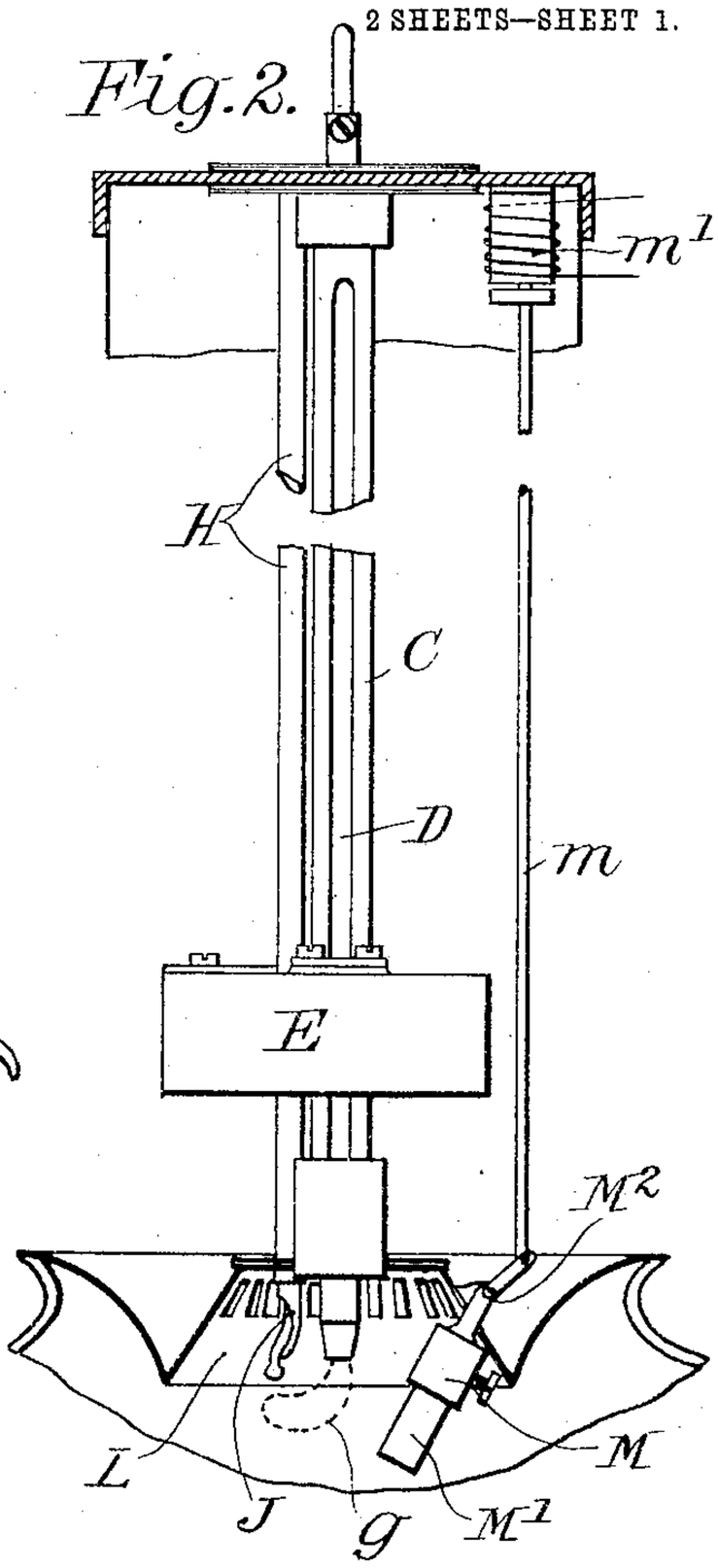

Fig. 3.

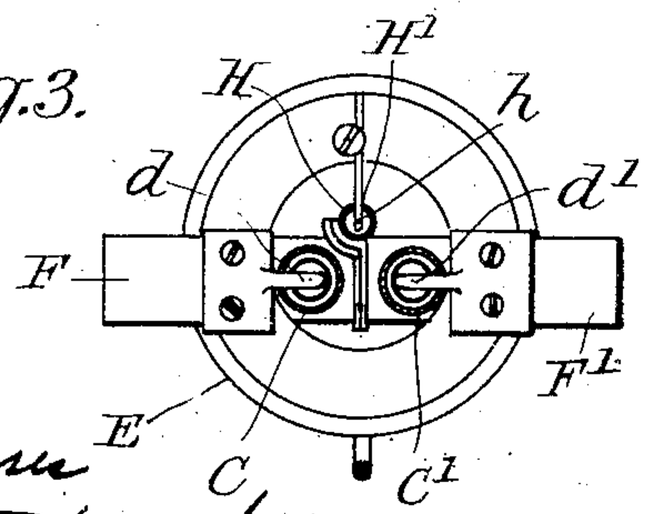

Fig. 8.

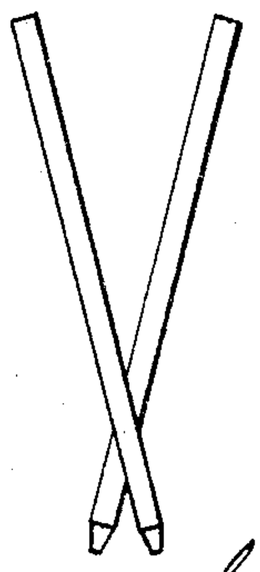

Fig. 8a.

Witnesses
Stephen Kinsta
W. Mayo Duvall.

Inventor.
Charles Oliver
by Wilkinson & Fisher
his Attorneys.

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2 SHEETS—SHEET 2.

Fig. 6.

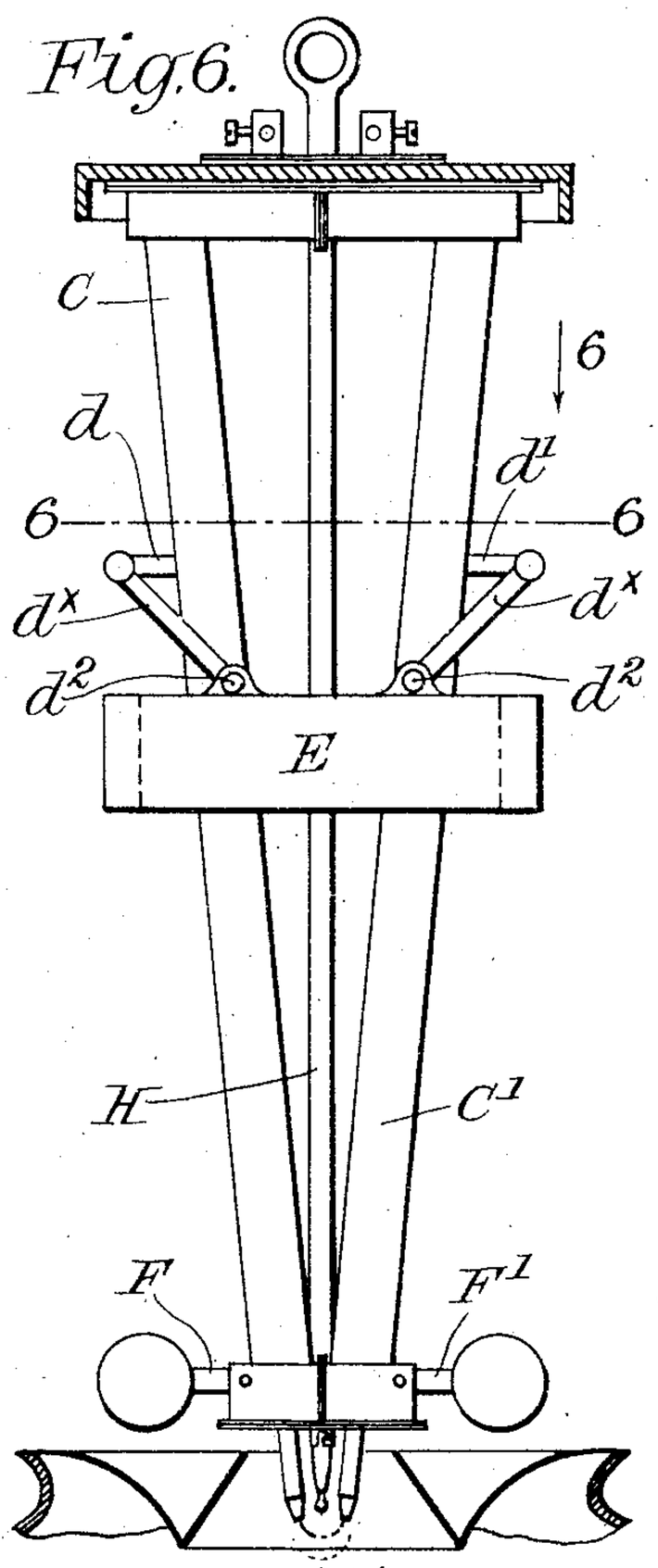


Fig. 7.

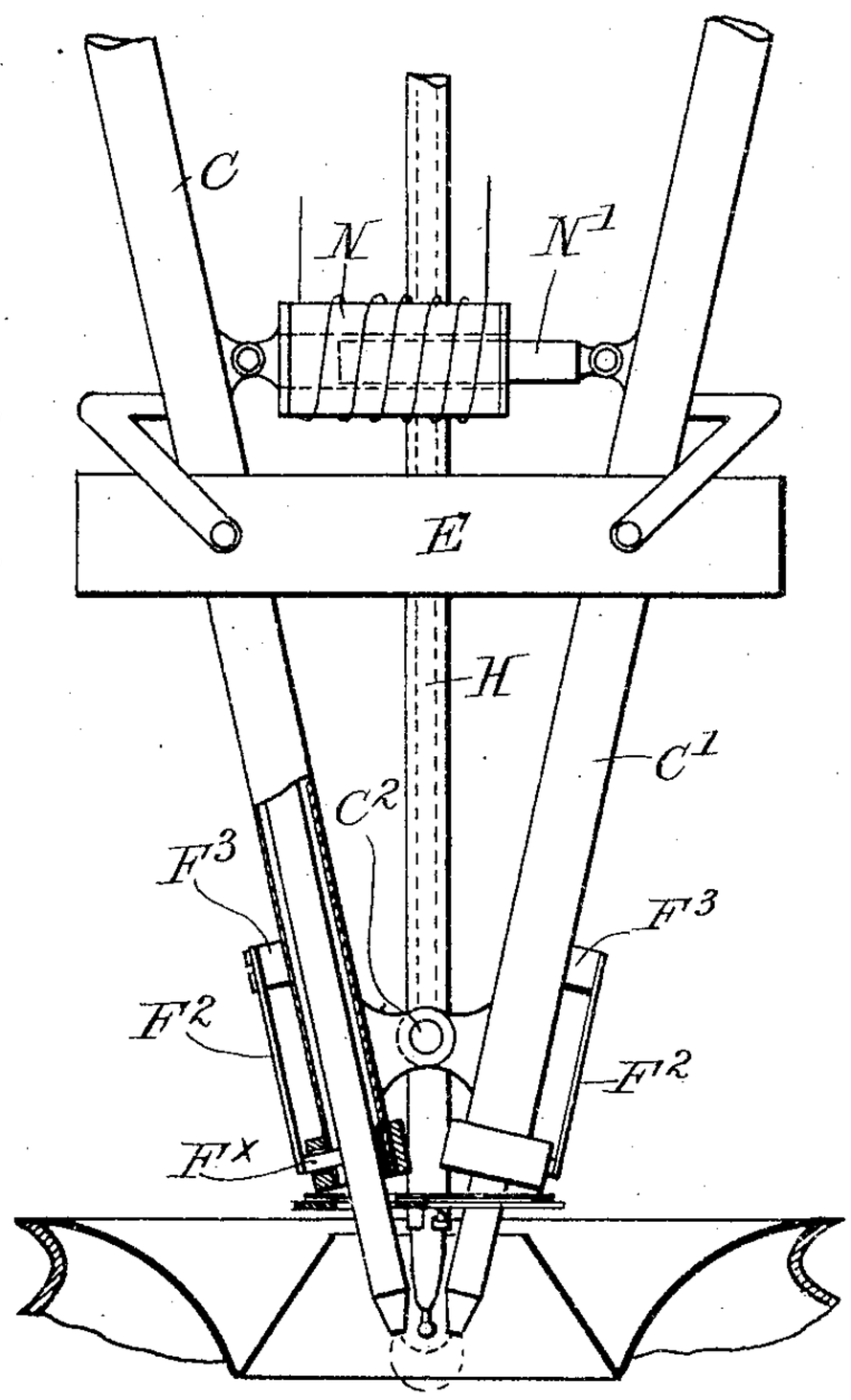


Fig. 6a.

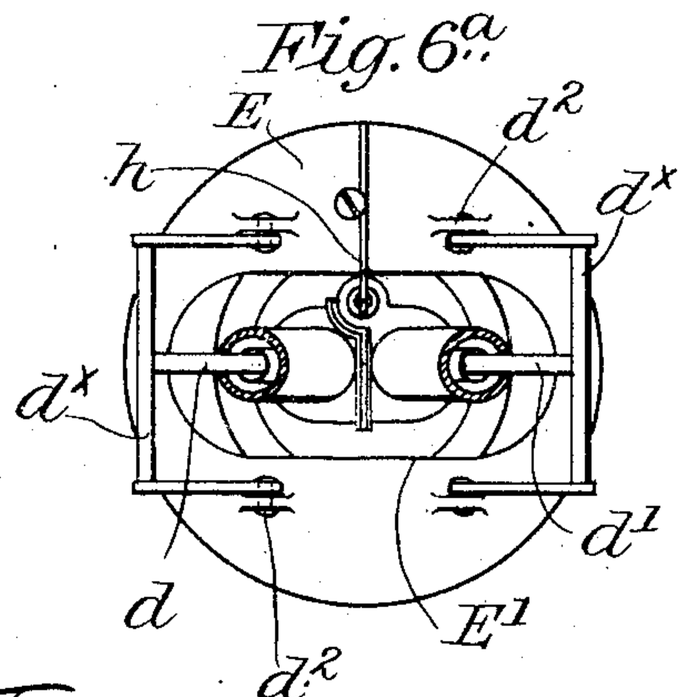


Fig. 4a

Fig. 4.

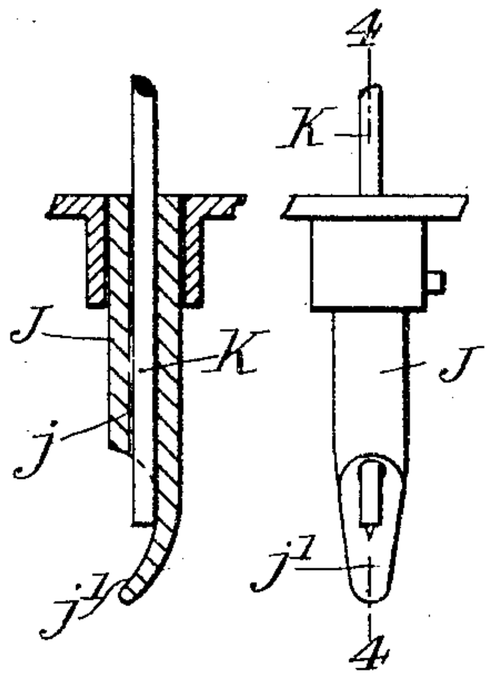
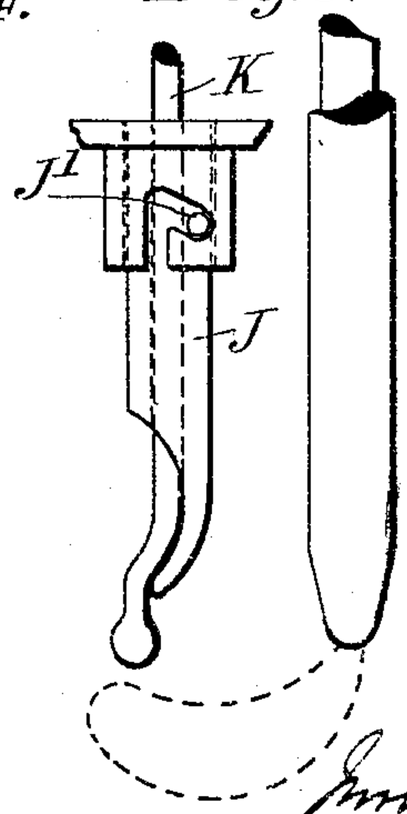


Fig. 5.



Witnesses:-
Stephen Bristol
W. Max. Duvall.

Inventor
Charles Oliver
by Wilkinson & Fisher
his Attorneys

No. 785,516. Patented March 21, 1905.

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 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.

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 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 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 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 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 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 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 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 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 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 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 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 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.

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 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 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 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 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

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 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 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 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 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 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 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, &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 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 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 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 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 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 alternating 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 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, &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 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 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 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.

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 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) 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.

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

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 inventiom 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′ A², Fig. 1, looking in the direction of the arrow B. Figs. 4 and 4ª are detailed drawings, showing fusible rod and stop, Fig. 4 being a view in elevation, and Fig. 4ª 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, 6ª, and 7 are detailed views of lamps arranged with inclined electrodes, each arrangement being hereinafter described. Figs. 8 and 8ª 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. 4ª 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 M²,) 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 4ª 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. 6ª 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 $d^{\times}$, 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. 6ª) 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 $d^{\times}$, 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^{2} 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^{2}, attached at F^{3} to the outside of each tube C C′, respectively, the lower end of each said spring F^{2} being provided with a pin $F^{\times}$, which is normally kept pressed inward by the spring F^{2} 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 $F^{\times}$. This spring-clip arrangement $F^{2}F^{\times}$, 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 8ª 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 electrobes, 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.

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. 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.

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, 4ª and 5.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES OLIVER.

Witnesses:

HENRY BIRKBECK,

HERBERT D. JAMESON.