(No Model.) 2 Sheets—Sheet 1.

M. G. FARMER.

ELECTRIC ARC LAMP.

No. 316,765. Patented Apr. 28, 1885.

Fig. 1.

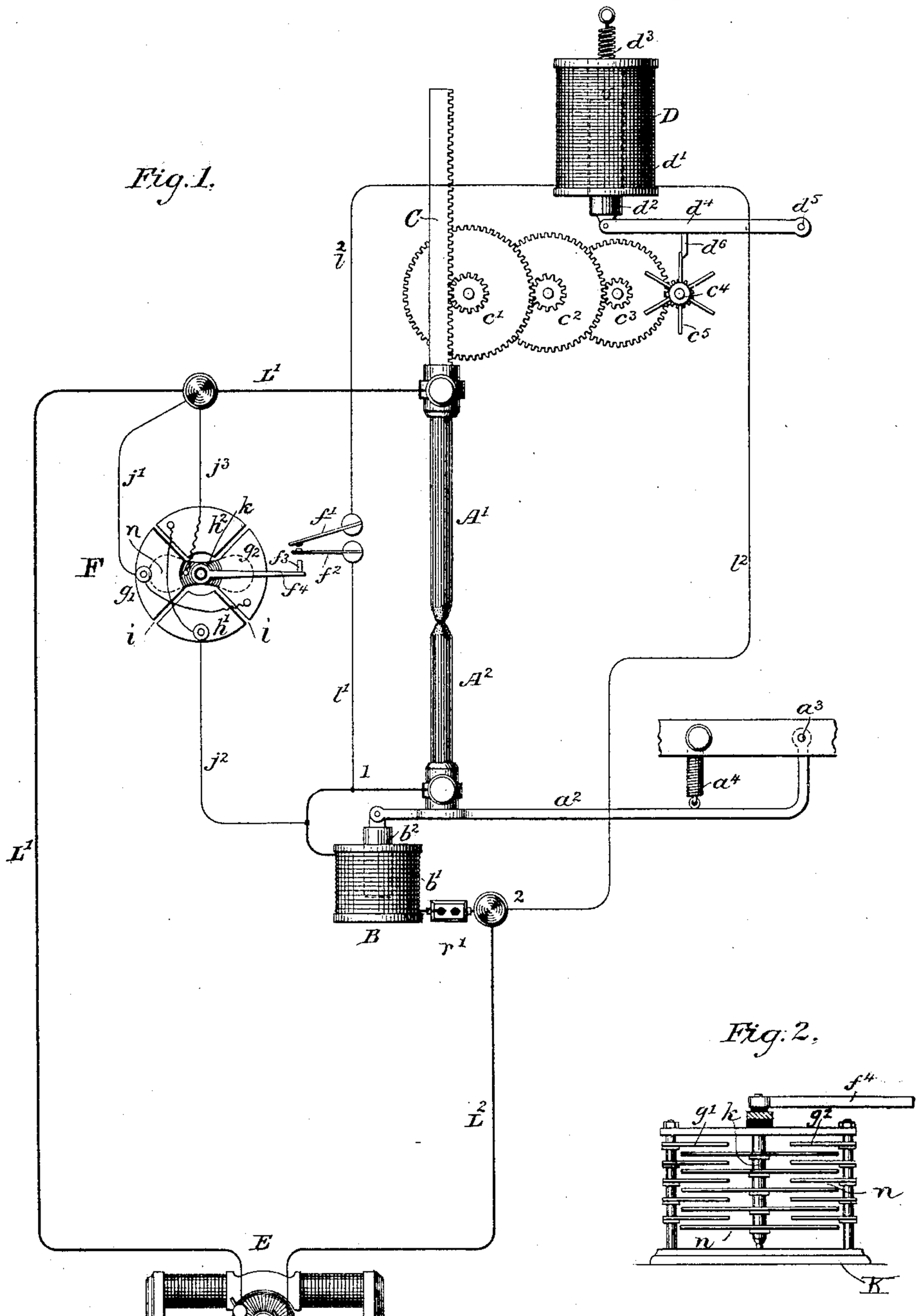

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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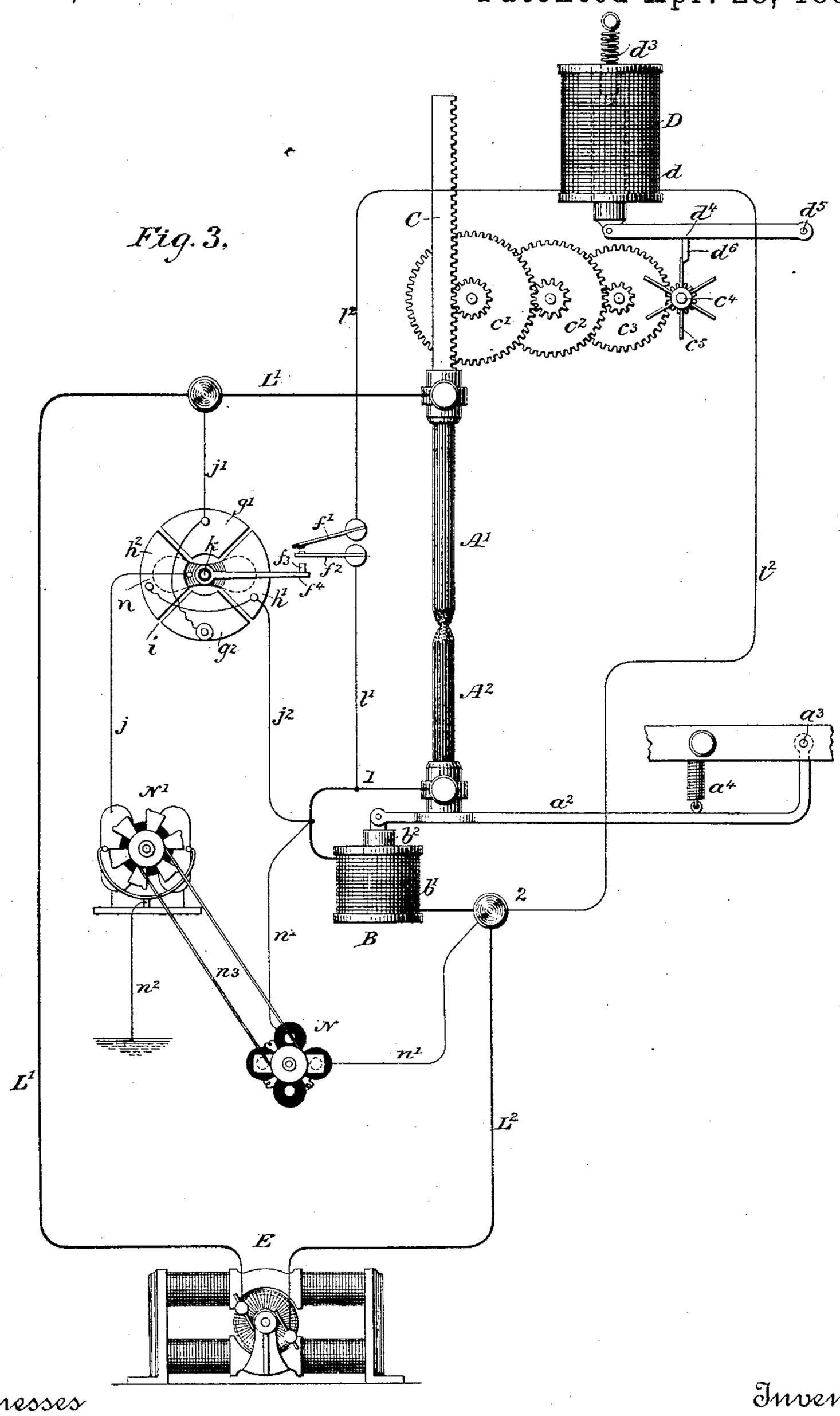
Fig. 3.



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UNITED STATES PATENT OFFICE.

MOSES G. FARMER, OF NEW YORK, N. Y.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 316,765, dated April 28, 1885.

Application filed November 12, 1884. (No model.)

To all whom it may concern:

Be it known that I, MOSES G. FARMER, a citizen of the United States, residing in New York, in the county and State of New York, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

My invention relates to the class of apparatus employed for so controlling the movements of the electrodes of electric-arc lights that they may be caused to automatically separate from each other a sufficient distance to establish the arc, and be fed toward each other, as may be required, to compensate for their consumption.

The invention consists, generally, in organizing the apparatus in substantially the following manner: The lower electrode of the lamp is carried upon a yielding arm, which, so long as no current traverses the conductors of the lamp, stands in an extreme upward position. When, however, a current is established through the lamp, the support of the lower electrode is drawn downward by the action of an electro-magnetic device a sufficient distance to establish an arc of the proper length. The upper electrode is suspended in any convenient manner, so that it may be fed forward gradually or from time to time as the two electrodes are consumed by the action of the current traversing the lamp. Any suitable electro-magnetic devices may be employed for regulating the movements of the upper electrode. These devices are, however, controlled through the instrumentality of an electrometer, which is actuated by the changes in potential, which are occasioned by the variations in the length, and thus in the resistance, of the arc formed between the electrodes. For this purpose an instrument of the character known as the "Thomson electrometer" is employed. One of the electrodes of the lamp is connected with the one set of quadrants of the electrometer, and the other electrode is connected in like manner with the remaining set of quadrants. The needle of the electrometer is connected with one of the electrodes or the conductor leading thereto, and thus receives its charge therefrom. Upon the axis of the needle of the electrometer there is carried a circuit-controlling device, which serves, when the needle has been moved by a predetermined increase in potential of the electrodes, to close the connections of a branch or derived circuit through the coils of an electro-magnetic device employed for controlling the advance movement of the upper electrode. When this circuit is completed, the upper electrode is released, and is permitted to advance a sufficient distance to render the arc of such length that by reason of the decreased resistance offered to the current the potential will be reduced to its normal amount. The electrometer will therefore move in the opposite direction, thereby causing the connections of the branch circuit to be interrupted, and preventing the further advancement of the electrodes.

For the purpose of insuring a reliable electrical connection by the action of the electrometer I propose to construct the same with several needles and corresponding quadrants, which act conjointly to move the circuit-closing device. A further modification in the construction of the electrometer consists in covering each plate or quadrant with a sheet of mica or other similar material for the purpose of intensifying its action.

The branch or derived circuit has its connections completed upon one side of the arc, and it does not therefore constitute a shunt around the arc.

In the accompanying drawings, illustrating my invention, Figure 1 is a diagram showing the general organization of parts, together with certain details in the construction of the apparatus; and Fig. 2 illustrates the organization of the electrometer. Fig. 3 illustrates a modification in the organization of the apparatus.

Referring to the drawings, E represents any suitable source of electricity—such as a dynamo-electric generator—adapted to supply the necessary current for operating one or more lamps, whether connected in series or in multiple arc. A conductor, L′, leading from the positive pole of this generator, is connected with the upper electrode, A′, of the lamp. The lower electrode, A^2, of the lamp is connected through its support a^2 and a conductor, L^2, with the negative pole of the generator E. The conductor L^2 includes in its circuit the coils b' of an electro-magnetic device, B. These coils are preferably of large

conductors and few convolutions. Within the coils b' there extends a movable core, b^2, which is supported from the end of the arm a^2 which carries the electrode A^2. The arm a^2 may be either a flexible spring or a lever pivoted at a point, a^3, to the frame of the lamp. In the latter case it is provided with a spring, a^4, normally tending to hold it upward, with core b^2 drawn a slight distance out from the coils b', as shown in the drawings. When the circuit-connections of the lamp are completed, the current traversing the coils b' of the device B serves to draw the core downward a sufficient distance to separate the electrode A^2 from the electrode A' as great a distance as may be required for establishing the arc, it being understood that the two electrodes previously rest in contact with each other. It will be evident, however, that as the electrodes are gradually consumed by the action of the current, some means must be provided for maintaining the arc at its proper length. The slight upward movement of the support a^2, which will be occasioned as the resistance of the arc increases, and the attraction exerted upon the core b^2 is reduced by the consequent diminution of the current traversing the coils b', will to some extent compensate for this consumption; but the movement of the lower electrode which may thus be occasioned is quite limited, and it is essential that one of the electrodes be fed forward toward the other. To accomplish this the electrode A' is supported in this instance by means of a rack-bar, C, the teeth of which are engaged by a toothed wheel, c'. A train of gear-wheels, c^2 c^3, connects the wheel c' with an escapement or fly wheel, c^4. When the fly-wheel c^4 is free to revolve, the weight of the carbon and the bar C causes the upper electrode to descend toward the lower.

For the purpose of controlling the movements of the wheel c' and bar C, an electromagnetic device, D, is employed. This device consists of coils d', surrounding a movable core, d^2. The coils d' are of fine wire and many convolutions. The core d^2 is suspended by means of an adjustable spring, d^3, but its weight is sufficient to normally hold it downward, projecting slightly beyond the coils d'. When, however, the coils are traversed by a current of sufficient strength, the core d^2 will be raised, it being drawn farther into the coil in a manner well understood. At the lower end of the core d^2 there is pivoted one end of a lever, d^4, the remaining end of which is pivoted to a stationary support at d^5. Upon the lever d^4 there is carried an arm or projection, d^6, constituting a brake for the wheel c^4. This arm may act either directly upon the periphery of a smooth wheel, or it may be constructed, as shown in the drawings, to engage the radial projections of arms c^5 of the fly-wheel. When the core d^2 is in its downward position, the wheel c^4 is thus prevented from turning, and the electrode A' remains at rest. When, however, the core is caused to rise, the wheel is released, and the weight of the electrode and its supporting-bar causes both to descend until the core d^2 is again lowered, causing it to interrupt the movement of the wheel. For the purpose of thus controlling the movements of the core d^2, and, through its instrumentality, the movements of the upper electrode, A', a conductor, l', leading from a point, l, in the conductor L', preferably upon one side of the coil b', is connected with a contact arm or spring, f'. A contact-point, f^3, carried upon an arm, f^4, extends from the arbor of a circuit-controlling electrometer, F, and this is designed to strike against the spring f'. This electrometer will be hereinafter fully described. A conductor, l^2, leads from a second contact-spring, f^2, through the coils d' of the device D to a point, 2, in the conductor L^2 upon the opposite side of the coil b'. When, therefore, the electrometer is so operated as to place the spring f^2 against the spring f', and thus complete an electric circuit from the conductor l' to the conductor l^2, a branch or derived circuit is formed from the point 1 to the point 2 in the conductor L^2, and a portion of the main-line current will therefore traverse the coils d', sufficient to actuate the device D in the manner described. This branch circuit, it will be understood, is not a shunt around the arc, and the amount of current traversing it when its connections are complete will depend upon the amount of resistance contained in the conductor L^2 between the points 1 and 2. By placing these points upon opposite sides of the coil b', a sufficient amount of resistance is usually secured to cause the required amount of current to traverse the conductors l' l^2; but an adjustable artificial resistance, r', may, if desired, be placed in the portion of the main line L^2 between the points 1 and 2. An important advantage secured by placing these coils between the points 1 and 2 should be here noticed, namely: When the springs f' and f^2 are placed in contact, and a small portion of the main-line current, sufficient to actuate the device D and to cause the upper electrode to approach the lower, is caused to traverse the branch circuit, then the current traversing the coils b' will be correspondingly reduced. The core b^2 will therefore be drawn farther out of the coil, and the lower electrode will thus be moved slightly toward the upper electrode. The arc of the lamp will thus be shortened by the simultaneous movement of both electrodes. This result is desired for the reason that owing to the time required for the core d^2 to discharge and for the advance movement of the upper electrode to be arrested, the latter is liable to approach more nearly to the lower electrode than is required for establishing an arc of the normal length, and consequently of sufficiently low resistance to permit the electrometer to open the circuit-connections. The downward movement of the lower electrode, A^2, however, when the con-

nections of the branch circuit are again interrupted, very nicely compensates for this excess of movement on the part of the upper electrode.

The electrometer F is designed to operate through the instrumentality of the changes in the electrical condition of the two electrodes A′ and A².

It is well known that when the current of the generator is allowed to traverse from one electrode to the other across an arc having but little resistance the potential of the current is correspondingly small. If, however, the resistance of the arc be increased, then will the electrical potential at the extremities of the arc be correspondingly increased. It is by these changes of potential that the regulation of the lamp is effected.

The instrument F, having the characteristics of a Thomson electrometer, is employed for controlling the movements of the arm f^4 and causing the circuit-connections to be completed from the spring f' to the spring f^2 when the length of the arc is too great. The instrument F consists of a series of metallic quadrants, *g h*, similar to those employed in the Thomson electrometer, which are supported around a central axis or arbor, *k*, in any suitable stationary frame, K. Four quadrants are placed in a plane, as shown at g', g^2, h', and h^2, and beneath these four more are placed in a parallel plane. In the drawings I have indicated five of such sets of quadrants. The diametrically-opposite quadrants are electrically connected with each other, but the intervening quadrants are insulated therefrom. The entire series of quadrants are so organized that the spaces *i* between them are in vertical planes, and the quadrants which constitute a vertical series are in electrical connection with each other. Thus all the quadrants indicated by the letter *g* are brought into connection with each other, and likewise those indicated by the letter *h*. The quadrants *g* are connected by a conductor, j', with the electrode A′, and the quadrants *h* are connected by a conductor, j^2, with the electrode A². Upon the arbor *k* a series of thin flat metallic plates, *n*, similar to those employed in the electrometer is supported, and these plates extend between the different sets of quadrants.

It is customary in the electrometer to impart to the movable plate a constant electric charge by connecting it with the Leyden jar, or in some similar manner. For the purposes of my invention, however, it is not necessary that the charge of the needle-plates be constant, and they are preferably connected by a conductor, j^3, with the conductor L′, leading to the upper electrode, A′.

It will now be understood that when the lamp is in its normal state of operation the quadrant-plates *g* and the needle-plates *n* will be each positively charged to a given degree, and the quadrant-plates *h* will be negatively charged. The needle-plates, being free to revolve, will stand in a predetermined position, with the arm f^4 out of contact with the spring f^2. When, however, the arc of the lamp becomes elongated and its resistance increased, the quadrants and the needle-plates become charged to a greater degree. The plates *n* will therefore be repelled from the quadrants *g* and attracted toward the quadrants *h* with greater force, and when the arc has attained a predetermined length the circuit will be completed from the spring f' to the spring f^2. The device D will therefore be actuated and the regulation of the electrodes effected in the manner already described.

The number of quadrants which it may be advantageous to employ will depend upon the amount of force required to secure a reliable contact at the points *f*. For the purpose of obtaining as good results as possible from the instrument I prefer to coat the surfaces of the quadrants *g* and *h* with mica, resin, sulphur, hard rubber, or other suitable non-conducting material.

The needle-plates of the lamp may be charged by means of a replenisher, as indicated in Fig. 3. In this case a motor, N, is shown as included in a branch conductor, n'. The conductor n' is represented as leading from one side of the electro-magnet B through the motor N to the opposite side of the electro-magnet. It is evident, however, that this conductor might be a branch at some other point in the system. A belt, n^3, connects the motor with a replenisher, N′, the construction of which is well understood and requires no further description. The collecting-plate of the replenisher is connected by the conductor *j* with the needle-plate *n* of the electrometer, while the collecting-points of the replenisher are connected with the earth by a conductor, n^2.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, of the upper and the lower electrode of an arc lamp, an electro-magnetic device for controlling the movement of one of said electrodes toward the other, and a Thomson electrometer having its opposite plates connected with the respective electrodes, for controlling the operations of said electro-magnetic device through the instrumentality of the changes in electrical potential at the electrodes.

2. The combination, substantially as hereinbefore set forth, of the upper and lower electrode of an electric-arc lamp, an electrometer having its respective plates connected with the respective electrodes, and actuated by changes in potential caused by the varying length of the arc, and a device for governing the approach of the electrodes, which device is controlled by said electrometer.

3. The combination, substantially as hereinbefore set forth, of the electrodes of an arc lamp, an electrometer having its positive and

its negative quadrants connected with said electrodes and its movable plate connected with one of the same, and an electro-magnetic device included in a derived circuit or a branch of the main line, the connections of which are controlled by said electrometer.

4. The combination, substantially as hereinbefore set forth, of the electrodes of an electric-arc lamp, two electrifiable plates or two sets of the same, respectively connected with said electrodes, a movable electrified plate, an electro-magnetic device for regulating the arc of the lamp, and a circuit for said device having its connections controlled by the movements of said movable plate.

5. The combination, substantially as hereinbefore set forth, of the electrodes of an arc lamp, an electrically-charged plate moved to and fro by the variations in electrical potential occasioned by the variations in the length of the arc of the lamp, and a regulator controlled by the movements of said plate.

6. The combination, substantially as hereinbefore set forth, of an electro-magnetic regulator for electric lamps and an electrometer statically charged by the currents passing to and from the arc, substantially as described, serving to control the operation of said regulator.

7. In an electric-arc lamp, the combination, substantially as hereinbefore set forth, of an upper electrode, the lower electrode, a yielding support for the same, an electro-magnet included in the main-line conductor, and serving, when vitalized, to separate the lower electrode from the upper electrode, an electro-magnet serving to control the approach of the upper electrode toward the lower electrode, a conductor leading from opposite sides of the first-named electro-magnet and including the coils of the second electro-magnet, and means, substantially such as described, governed by the variations in the length of the arc of the lamp, to control the action of the second electro-magnet.

8. The combination, substantially as hereinbefore set forth, of the electrodes $A' A^2$, the device D, included in a branch circuit for determining the approach of the electrodes, the electrometer F, and the circuit-controlling device operated by said electrometer for controlling the operation of the device D.

9. The combination, substantially as hereinbefore set forth, of an electro-magnetic regulator for electric lamps, an electrometer serving to control the operation of said regulator, and means, substantially as described, for charging the plates of said electrometer.

In testimony whereof I have hereunto subscribed my name this 26th day of August, A. D. 1884.

MOSES G. FARMER.

Witnesses:
DANL. W. EDGECOMB,
CHARLES A. TERRY.