(No Model.)

2 Sheets—Sheet 1.

N. S. KEITH.

ELECTRIC ARC LAMP.

No. 272,262. Patented Feb. 13, 1883.

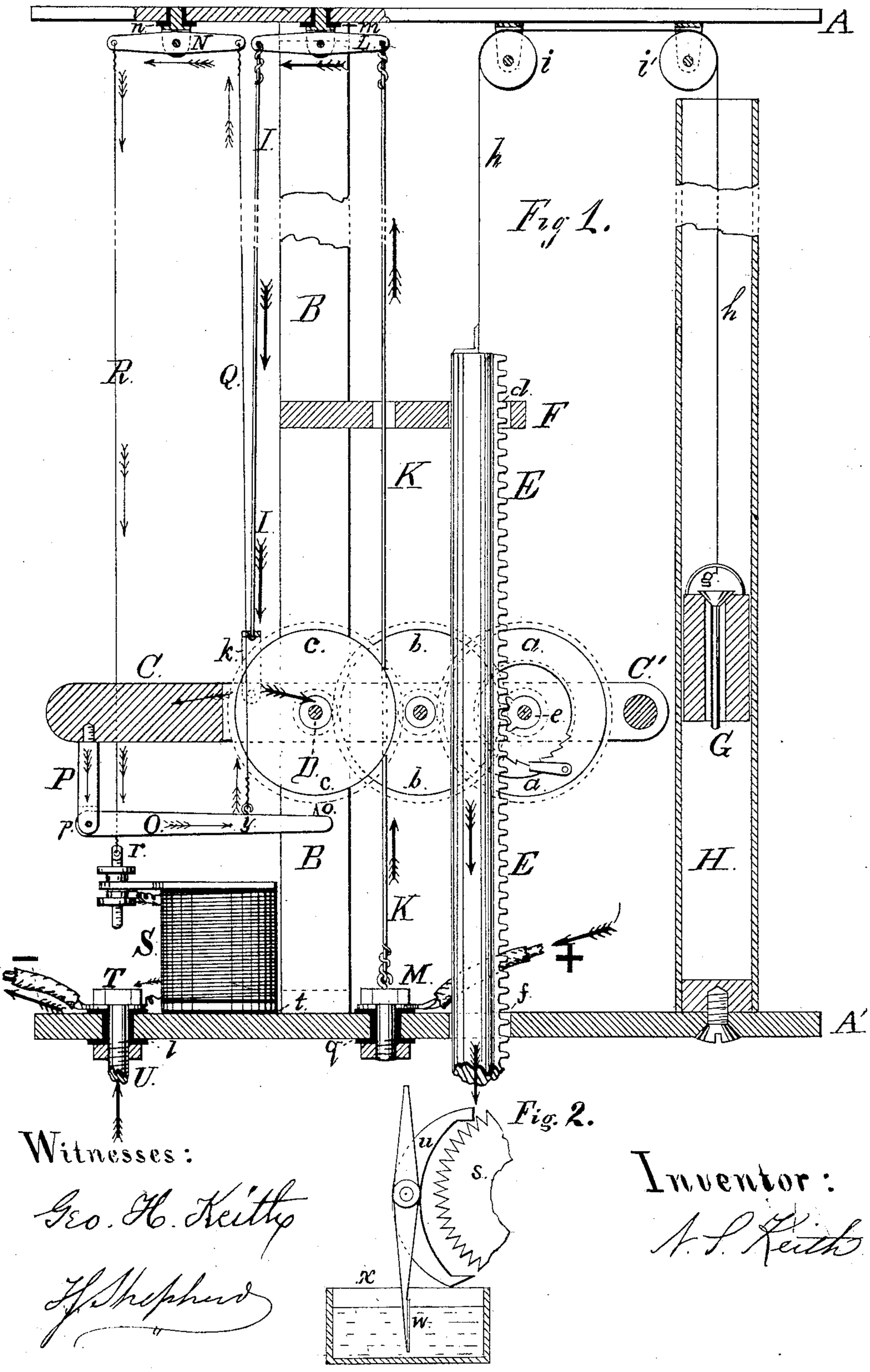

Fig. 1.

Fig. 2.

Witnesses:

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F. F. Shepherd

Inventor:

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(No Model.) 2 Sheets—Sheet 2.

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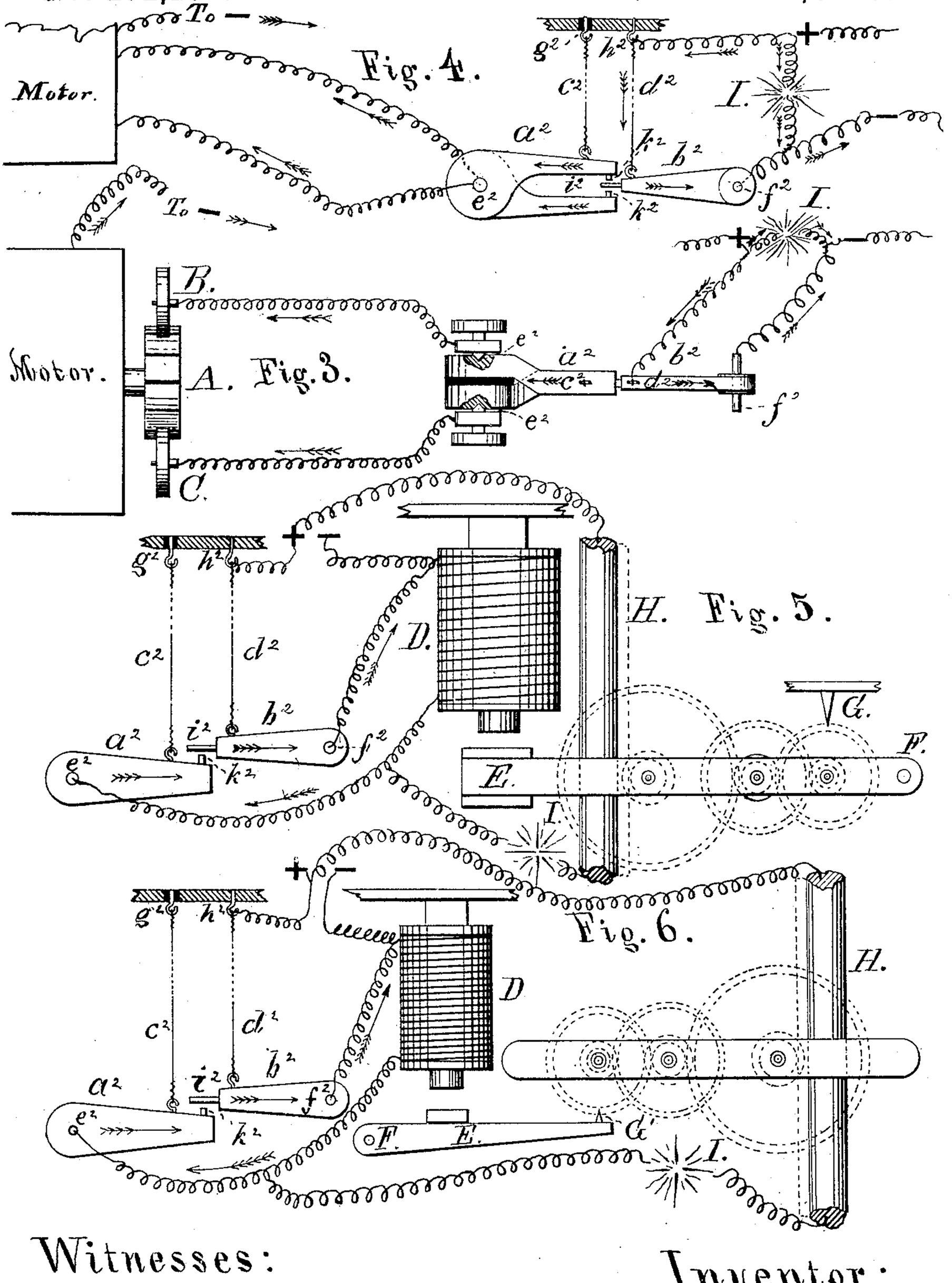

Fig. 4.

Fig. 5.

Fig. 6.

Witnesses:

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Inventor:

N. S. Keith.

UNITED STATES PATENT OFFICE.

NATHANIEL S. KEITH, OF NEW YORK, N. Y., ASSIGNOR TO THE KEITH ELECTRIC COMPANY, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 272,262, dated February 13, 1883.

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

To all whom it may concern:

Be it known that I, NATHANIEL SHEPARD KEITH, of the city, county, and State of New York, have invented a new and useful Improvement in Electric-Arc Lamps; and I do hereby declare that the following is a full and exact description of it, sufficient to enable others skilled in the art to make and use the same.

Accompanying this specification are drawings, to which reference is made by figures, letters, and numbers.

This lamp belongs to what is known as the "arc" type, and is designed to work without the use of electro-magnets, solenoids, or other magnetic devices, as well as to insure greater steadiness and precision than have been attained in lamps the workings of which are controlled by magnetic devices.

A A′ are the top and bottom plates, respectively, of that portion of the lamp which contains the working parts. These plates are retained in immovable relation to each other by two metal posts, one of which is shown at B. Its mate is not shown, as its position is obvious, and if shown would obscure the view of working parts. Such other connections between the plates may be used as may be deemed necessary for strength or convenience. The posts B serve to support the train-bearing frame C C′ at the pivoting-point D. Only one-half of this frame C C′ is shown. The section is a longitudinal one, and the pivots at D are after any well-known mechanical form. The carbon-carrying rod E is of usual construction, with a rack on one side, the teeth of which engage the pinion *e* of the first wheel of the train of cog-wheels *a*, *b*, and *c*, and gives motion to this train by reason of its weight. This carbon-carrying rod is guided by running through two holes, one of which is shown at *d* in the bracket F, which is attached to the posts B, and the other at *f* in the plate A′. The top of the carbon-rod is connected with the piston G of a long dash-pot cylinder, H, nearly filled with glycerine, oil, or other liquid, by means of a thin metal band or cord, *h*, which passes over the drums *i i*. It is obvious that the speed of movement of the carbon-rod E is controlled by the speed of movement of the piston G. The movement downward of the rod will be slow, as the liquid in H must pass from the top to the bottom of G in the small space left between it and the walls of the cylinder H; but the movement downward of the piston G will be comparatively rapid by reason of the opening of the valve *g*, due to such movement. The end C of the train-bearing frame is made somewhat more than heavy enough, or is weighted, to raise the end C′, with its wheels *a* and *b*, the carbon-rod F, and its attachments. So it is a lever, the power being at the part C, the fulcrum at D, and the weight on the part C′. The part C of the frame is retained in its proper position by the wire I, of platinum or other suitable metal, which is attached to it through the stirrup K in obvious manner. The wire I is suspended from the lever, and is a continuance, as it were, of the wire K, also of platinum, from the fastening and positive electrical connection M. The lever L and the lever N are used to secure enough length of wire without making the apparatus too high and bulky. Eighteen inches between plates A A′ answers very well.

O is a lever carrying a detent, *o*, which detent engages at proper times the teeth of the wheel *c*, so that it controls the movement of the gear-wheels and carbon-rod E. The lever O is supported by the hanger P at the joint *p*, and is free to move at the joint. It is held in its proper position by the wire Q, of platinum or other suitable metal, which is suspended from the lever N. The wire R, also of platinum, connects N with the adjusting-screw, the office of which is obvious.

S is a resistance-coil, preferably of copper wire, which is used to control the current which may flow through the wires Q and R.

T is the negative electrical connection.

U is the electrical connection to the under part of the lamp and the negative carbon.

The under part of the lamp is not shown, as it does not differ in any essential particular from other lamps known in the art.

The heavy dark spaces show insulations, as at *l*, *m*, *n*, *q*, and *t*. The other electrical connections and insulations are made in the usual manner.

Figure 2 shows a device for retarding the movement of the carbon-rod, which may be used in the place of the dash-pot H. It consists of the escapement-wheel *s*, which may be

attached to the same arbor as the wheel *c*, Fig. 1, or may be run upon an arbor of its own by gearing from wheel *c*, Fig. 1, the escapement-lever *u*, the balanced pendulum *v*, the fan *w*, and the box, *x*, of glycerine, oil, or other liquid. Other known devices for the purpose may be used.

The operation of the lamp is as follows: Given the carbons as touching, the current flows in at + through M, wire K, lever L, wire I, saddle K, frame C C′, carbon-rod E, positive carbon, the "arc" negative carbon, the lower part of the lamp, the connection U T, and out at —. This course is shown by the heavy arrows. A small portion branches off at K and C and flows through hanger P, lever O, wire Q, lever N, wire R, screw *r*, resistance-coil S, and joins the main current at T, without entering the arc at all. Its course is shown by the light arrows. It is a derived circuit or shunt around the arc or light, and is made of comparatively high resistance to the main or light circuit. In obedience to the law of derived circuits, the current which flows in it is governed by the relative resistance of the main circuit. As the wires K and I are of material and size to offer resistance to the current enough to become heated, they expand, so increase in length, and allow the end C of the frame to move downward and raise the carbon-rod E, so as to form the arc. This it would not do, however, if the movement of C did not cause the detent *o* to engage the wheel *c*. The engagement is effected in this manner: The movement of C downward carries the end *p* of the lever O downward. Its suspending-point *y* acts as a fulcrum, so that the detent *o* is raised to engagement with C. There will be practically no increase in the length of the wires Q R until the separation of the carbons has increased the resistance of the main circuit so much as to increase the current in the shunt. By adjusting the size of the wires Q and R and their lengths to the requirements—which are that they lengthen enough by the current which flows in them to allow the disengagement of the detents when the arc is too long, and contract enough at or below the normal current to engage the detent with the wheel—the working of the lamp is insured. This adjustment is readily effected by using a size wire which is sufficiently strong to support the lever O under all reasonable circumstances without permanent set, and small enough to be raised by the current, say, 200° in temperature, more or less. The relative position of the detent *o* to the wheel *c* is nicely effected by the adjusting-screw J, which either raises or lowers the detent in obvious way. For reduction of the current which would flow through the wires Q and R alone, the resistance S is introduced to the circuit. No. 36 to No. 40 platinum wire answers very well for wires Q and R.

The size of the wires I K is determined by the current which is to be used by the lamp, and may range from, say, 30 to 16, or larger or smaller, according to current, but must always be of a size small enough to have their temperatures raised by the current, say, 200°, more or less. An increase of temperature of 200° will lengthen them, if about three feet in normal length, more than one-twentieth of an inch—enough to form an arc, in the case illustrated, of one-seventh of an inch. Of course more or less length of wire, greater or less size, and more or less temperature may be used without affecting the result only in degree. It will be seen that after the arc is formed the feed of the lamp is entirely controlled by the expansion and contraction of the wires Q and R, due to changes in the resistance of the arc. Thus when the arc becomes too long the increased temperature, due to increased current in the shunt, expands the wires and disengages the detent from the gear-work, thus stopping the downward movement of the positive carbon. As the wires of the two circuits are approximately of the same length, and are exposed to the same surrounding temperature, no changes in that respect will alter the relative positions of the detent *o* and wheel *c*.

I do not limit my invention to the particular devices shown, for it is evident that the expanding wire in the shunt can be used for moving detents, making or breaking circuits, and for moving other devices in electric lamps and regulators for the purpose of regulation or adjustment. Some of these I show in Figs. 3, 4, 5, and 6.

Fig. 3 is a plan view of an apparatus for reversing the movement of an electric motor used for forming and preserving the arc of an electric lamp by positively moving to or fro one of the carbons.

The motor attachment to an electric lamp is the subject of another application by me.

Fig. 4 is an elevation of the levers a^2 and b^2 of Fig. 3, showing the manner of suspension.

Fig. 5 is a view of an arrangement embodying my invention for controlling the feed of carbons in an electric lamp, in which an electro-magnet is used to lift a train of wheels and the positive carbon-rod to form the arc, and to engage one of the wheels with a fixed detent for stopping the feed.

Fig. 6 is a view of an arrangement embodying my invention for controlling the feed of carbons in an electric lamp, in which an electro-magnet is used to move a detent to and from engagement with one of a train of wheels connected with the carbon-rod.

In Figs. 3, 4, 5, and 6 like letters and numbers refer to similar parts.

The wires c^2 (in Figs. 4, 5, and 6) and d^2 should be of the same length and material, preferably platinum, though for cheapness c^2 may be of other metal or alloy whose rate of expansion from increments of temperature is the same as that of d^2.

The object of suspending the levers a^2 by the wires c^2 is to keep the relative positions of the contact-points i^2 and k^2 fixed under all conditions of surrounding temperature. As the rates of expansion of both c^2 and d^2 are alike, it is

evident that though their position may change in space, relatively they do not change under the same influences.

e^2 f^2 are the fixed pivoting-points of the several levers.

g^2 and h^2 are the fixed hooks or other attachments for the wires. g^2 is in every case insulated from the metal parts.

The + and — signs represent the positive and negative connections with the sources of electricity.

i^2 and k^2 are points of contact, preferably of platinum, for making circuit. In Figs. 3 and 4, when the wire d^2 has no current, or a weak one, flowing in it, it is sufficiently contracted to cause the point i^2 to rest upon the upper, k^2, making a circuit from the motor through its commutator A, contact-wheel B, upper pivot, e^2, upper part of lever a^2, lever b^2, pivot f^2, and thence to the negative connection. The current in this circuit causes the motor to move in the direction to separate the carbons. When the carbons have sufficiently separated, enough current passes through the shunt-wire d^2 to heat and expand it, so that the contact-points are separated and the motor comes to rest. When the arc has increased in length, more current passes through d^2, greater expansion takes place, and the other circuit is made, so that the motor runs in the direction to approach the carbons. This circuit is from the motor through contact-wheel c, lower e^2, lower part of lever, lower contact, k^2, lever b^2, and to negative connection.

In Fig. 5 expansion of d^2 brings the points i^2 and k^2 together and forms a derived circuit (denoted by the four arrows) from the electro-magnet D, shunts out enough of the current to decrease the magnetism of D, so that the armature end E moves by its gravity downward. As the lever bearing the train of wheels is pivoted at F, one of the wheels disengages from the fixed detent G by the movement, and the train moves by the gravity of the carbon-rod H until the normal arc is restored, and the wire d^2 consequently contracts and breaks the derived circuit. In Fig. 6 the operation is similar, except the electro-magnet D acts on a lever carrying the detent G. The main circuit in Figs. 5 and 6 is from the positive (+) sign through the carbon-rod H, light or arc I, electro-magnet D, to the negative (—) sign.

The special application of this invention to the cases illustrated in Figs. 3, 4, 5, and 6, and other cases, I leave for the subject of other applications for Letters Patent.

I am aware that expansions and contractions of wires in electric circuits have been utilized in the main circuits of electric lamps for forming the arc. Therefore I do not claim that mode; but I am not aware that wires or conductors changed in length by the heat of the current in them have been used in derived circuits or shunts around the arc for any purpose whatever before my invention. Therefore,

I claim—

1. The combination of an electric conductor forming a portion of a derived circuit around the electric arc, and adapted to expand by the heating effects of the derived current passing through it, feed mechanism connected to the carbon or carbon-carrier, and controlling devices adapted to control the action of the feed mechanism and connected with the expansible conductor, the whole arranged substantially as described, so that when said conductor expands under the action of an increased flow of current through it the controlling devices allow the feed mechanism to come into action and feed one of the carbons toward the other.

2. The combination, substantially as described, of suitable devices for separating the carbons to form the arc, an expansible electric conductor forming a portion of the derived circuit around the arc, a feed-train connected to one of the carbon-carriers, and devices adapted to control, directly or indirectly, the action of the feed-train, said devices being connected with the expansible conductor.

3. The combination, substantially as described, of a gear-train connected to a carbon-carrier, a detent or locking device for the train, an electric conductor forming a portion of a derived circuit around the arc, and adapted to expand by the heating effect of the current passing through it, and devices, substantially as described, controlled, either directly or indirectly, by the expanding conductor, and adapted to release the train from the detent, so as to produce the feed when the arc lengthens, and causes an increased flow of current through said conductor.

4. The combination, substantially as described, of a pivoted gear-train connected to the carbon-carrier, an expansible electric conductor in the main circuit, with the carbons connected to the frame supporting said gear-train, detent devices controlling the feed-train, and an expansible electric conductor adapted to control, directly or indirectly, said detent devices.

5. The combination, with the feed mechanism for an electric lamp, of a device for controlling the action of said feed mechanism in accordance with the fluctuations in the length of arc, constructed in two parts, one of which is movable with relation to the other, and two independent expansible supporting wires or strips for the two parts of the said controlling device, one or both of said wires being traversed by an electric current varied in strength by fluctuations in the length of arc.

6. The combination of a toothed wheel connected with the gear-train of a lamp, an expansible electric conductor in the main circuit supporting the gear-train, a detent for the toothed wheel, and an expansible electric conductor in a derived circuit connected to the detent, so as to move the same into and out of engagement with the wheel under variations of electric current flowing through it, said devices being constructed and arranged as described, so that when the two conductors are

subjected to equal degrees of temperature the relation of the wheel and its detent is not disturbed.

7. The combination, with the carbon-carrier, its pivoted gear-train lever, and an electric conductor connected to said lever and forming a portion of the main electric circuit, of a detent for said train, pivoted upon the lever, and an electric conductor forming a portion of a derived circuit around the arc, connected to said detent, and adapted by its expansion and contraction to throw the detent out of and into engagement with a wheel of the train.

8. The combination, substantially as described, of the pivoted gear-train lever, a detent supported or hinged to the lever, a toothed wheel of the train, and an expansible support or conductor for the detent, connected to the same in the manner described, so that when the end of the gear-train lever is depressed the detent is brought into engagement with the wheel.

9. The combination, substantially as described, of the pivoted lever carrying the gear-train engaging with the carbon-carrier, a detent-wheel whose pivot coincides with the fulcrum of the lever, a pivoted detent supported by the lever, and an expansible electric conductor connected to said pivoted detent, and forming a portion of the derived circuit around the carbons, the whole arranged substantially as set forth, so that the detent is caused to lock the wheel when the carbon-carrier is lifted to form the arc.

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