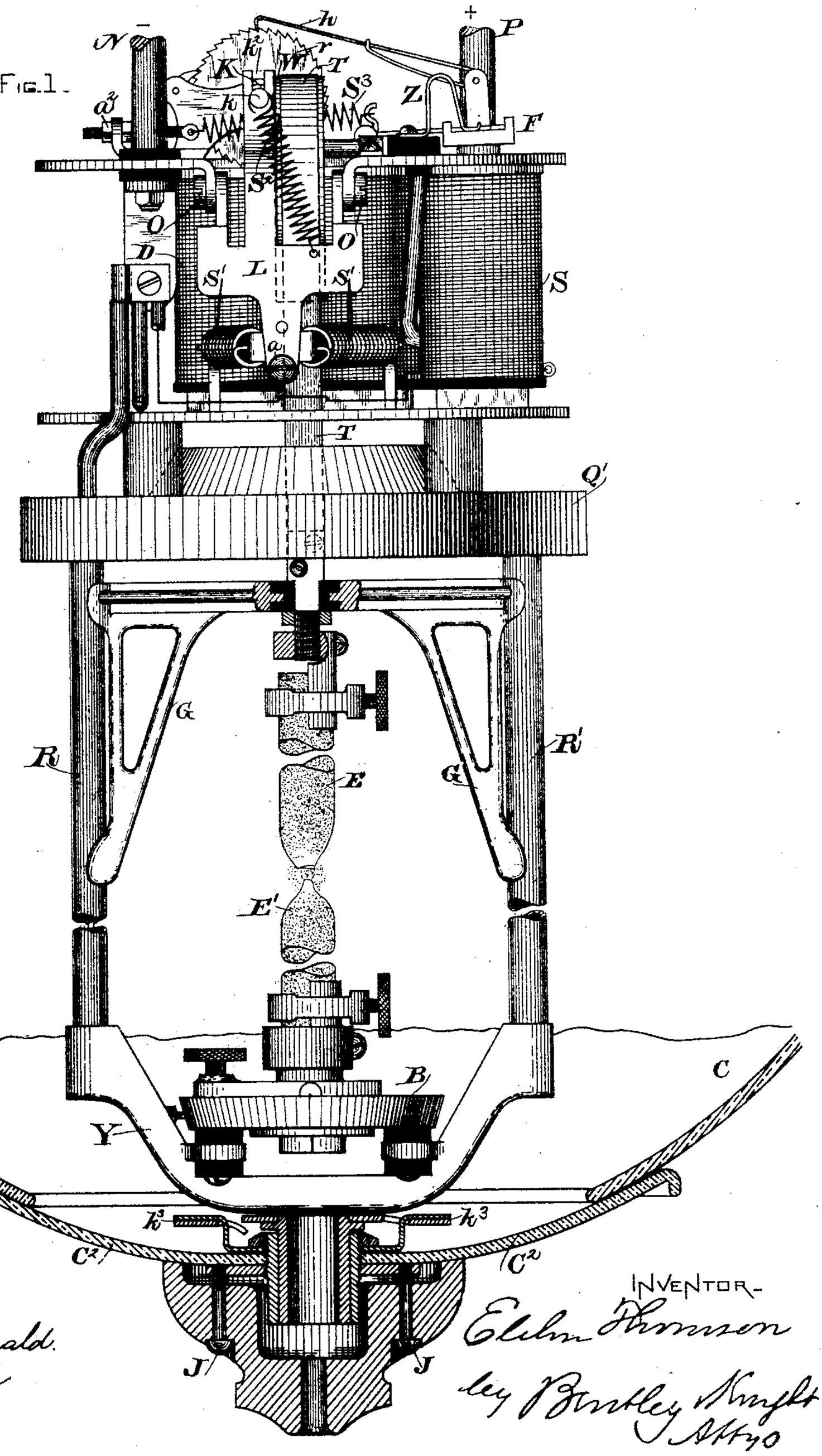
(No Model.) 4 Sheets—Sheet 1.

E. THOMSON.

ELECTRIC ARC LAMP.

No. 458,025. Patented Aug. 18, 1891.

Fig. 1.



WITNESSES.

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A. D. Cruse

INVENTOR.

Elihu Thomson

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Attys

(No Model.)

4 Sheets—Sheet 2.

E. THOMSON.

ELECTRIC ARC LAMP.

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FIG. 2.

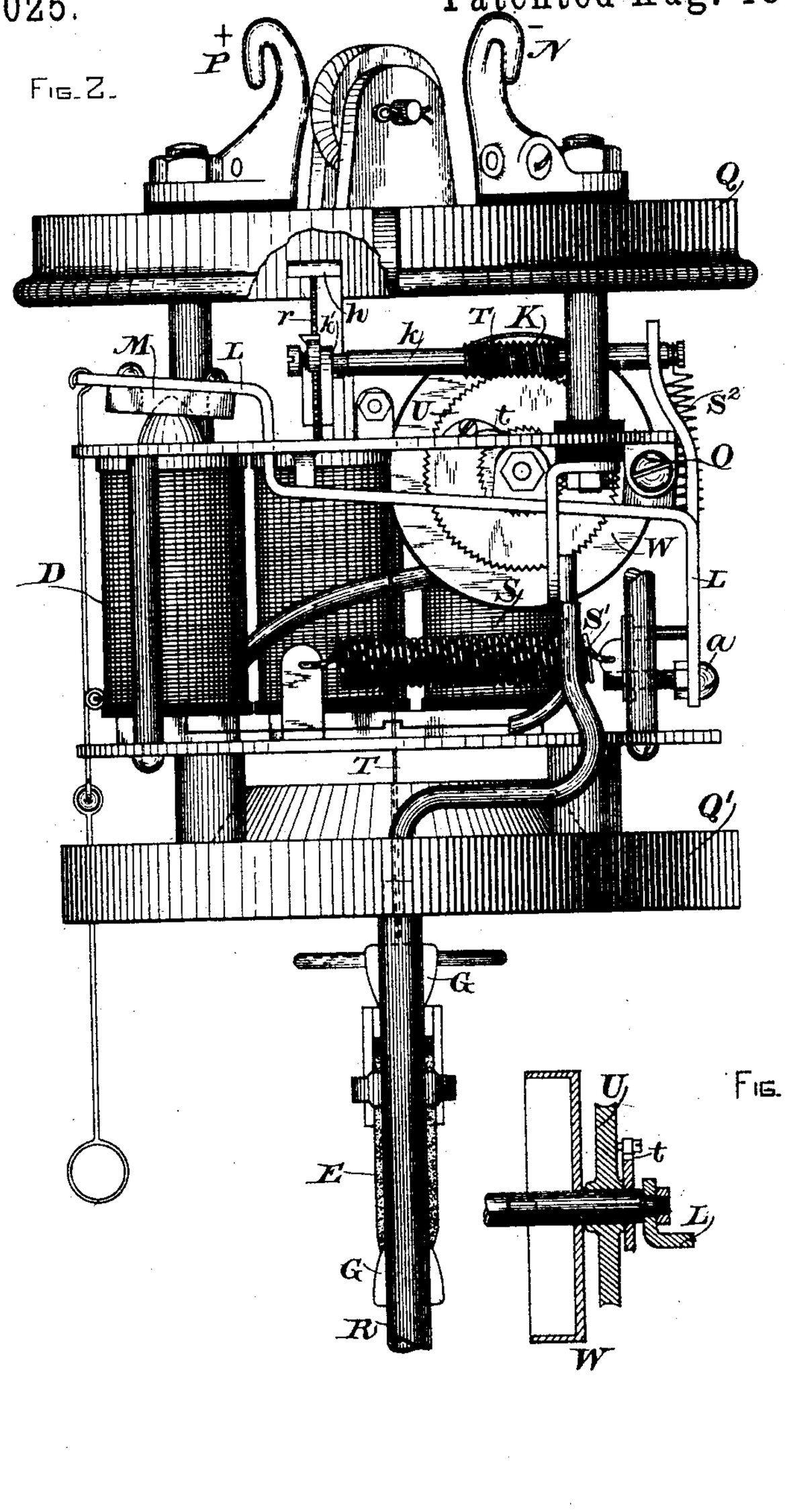

FIG. 11.

WITNESSES.

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(No Model.) 4 Sheets—Sheet 3.

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ELECTRIC ARC LAMP.

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Fig. 3.

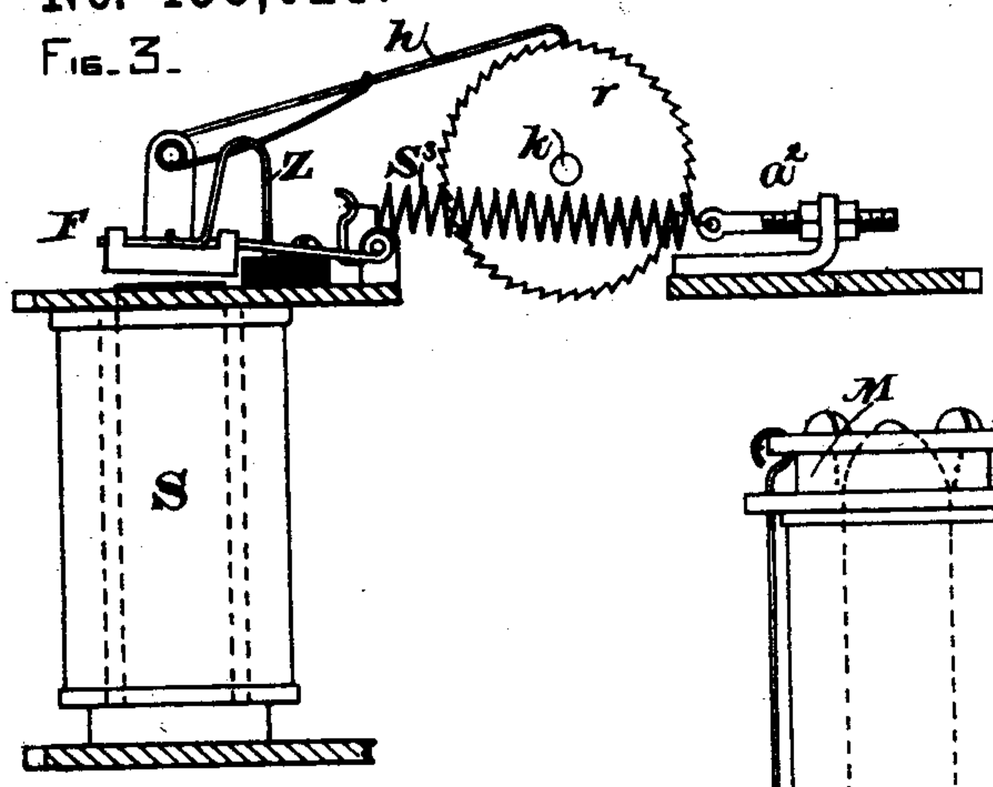


Fig. 4.

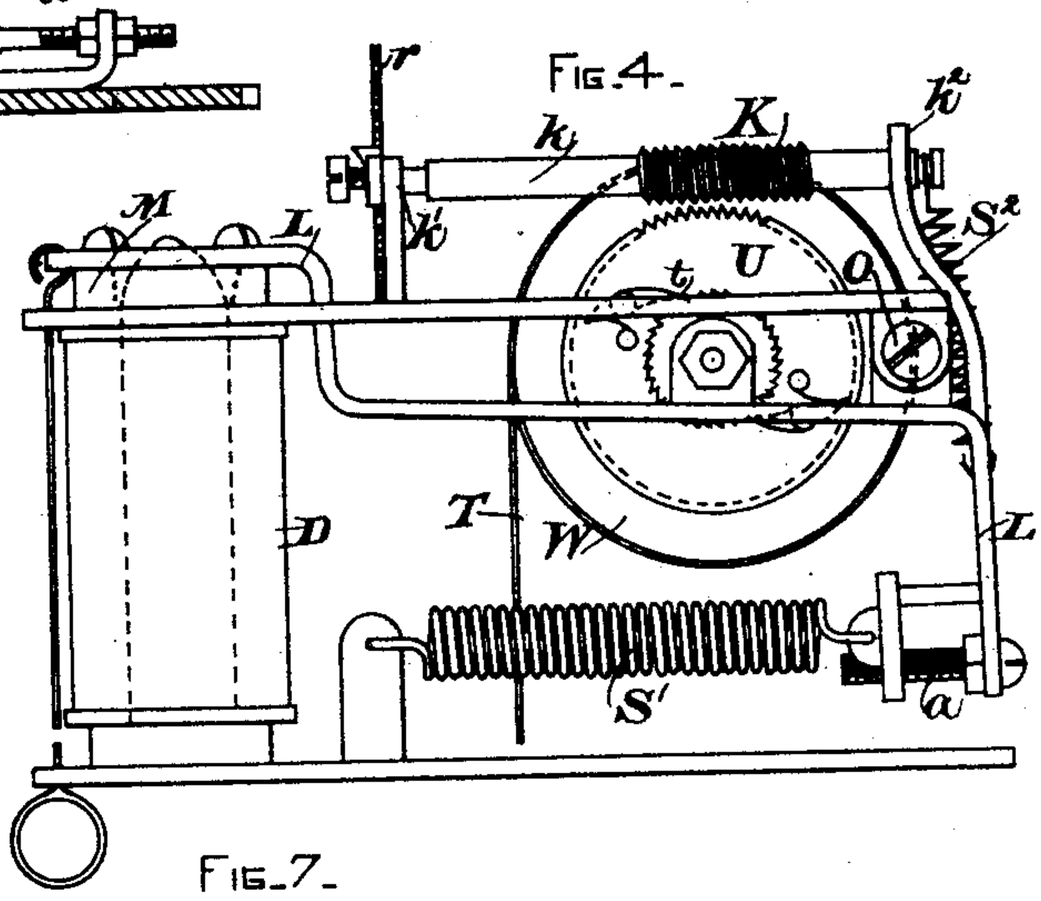


Fig. 5.

Fig. 7.

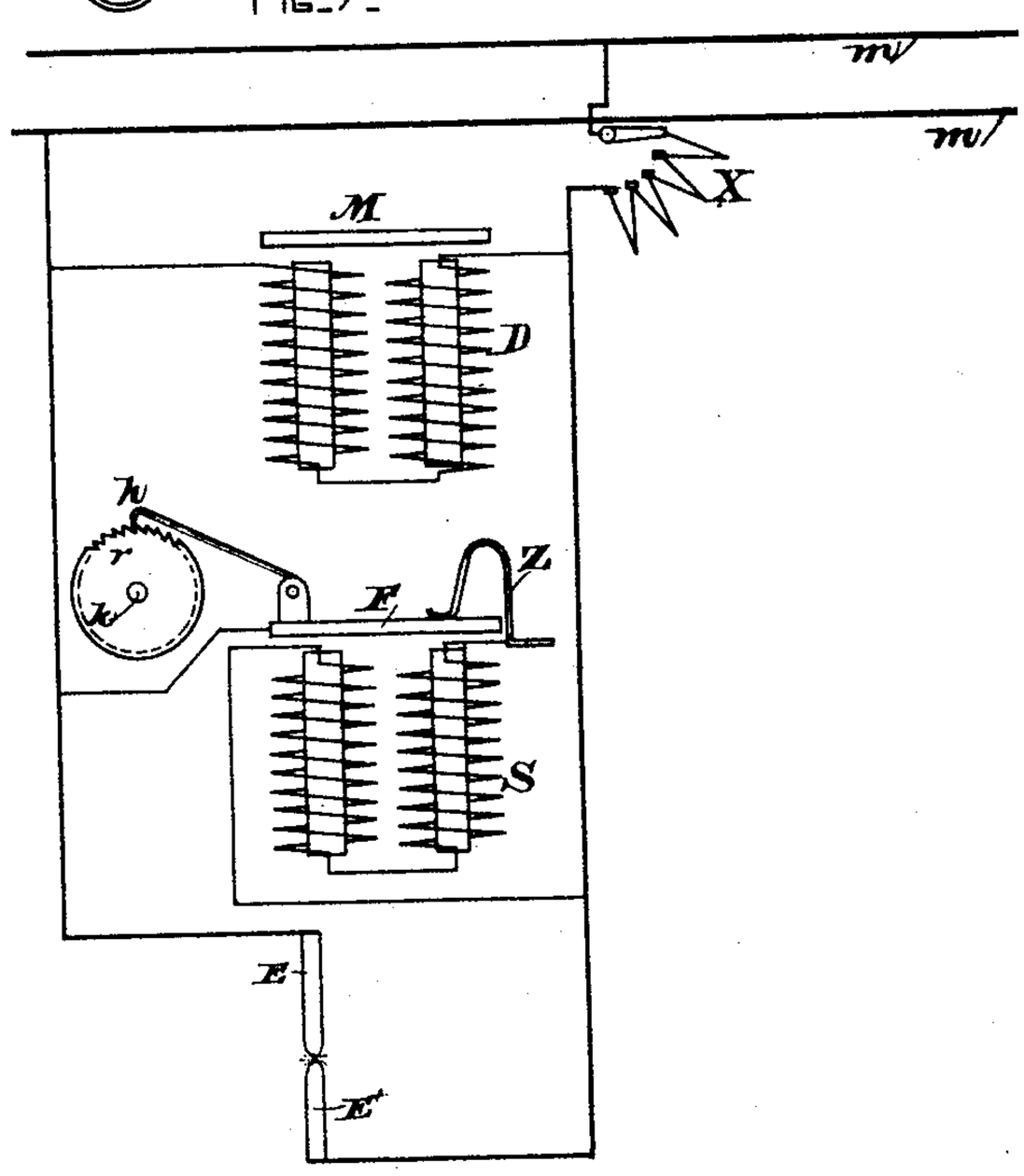
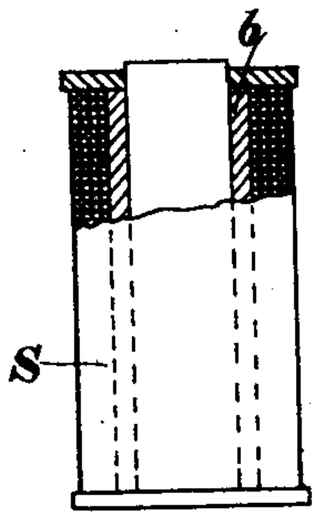


Fig. 6.



Witnesses.
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(No Model.) 4 Sheets—Sheet 4.

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ELECTRIC ARC LAMP.

No. 458,025. Patented Aug. 18, 1891.

FIG. 8.

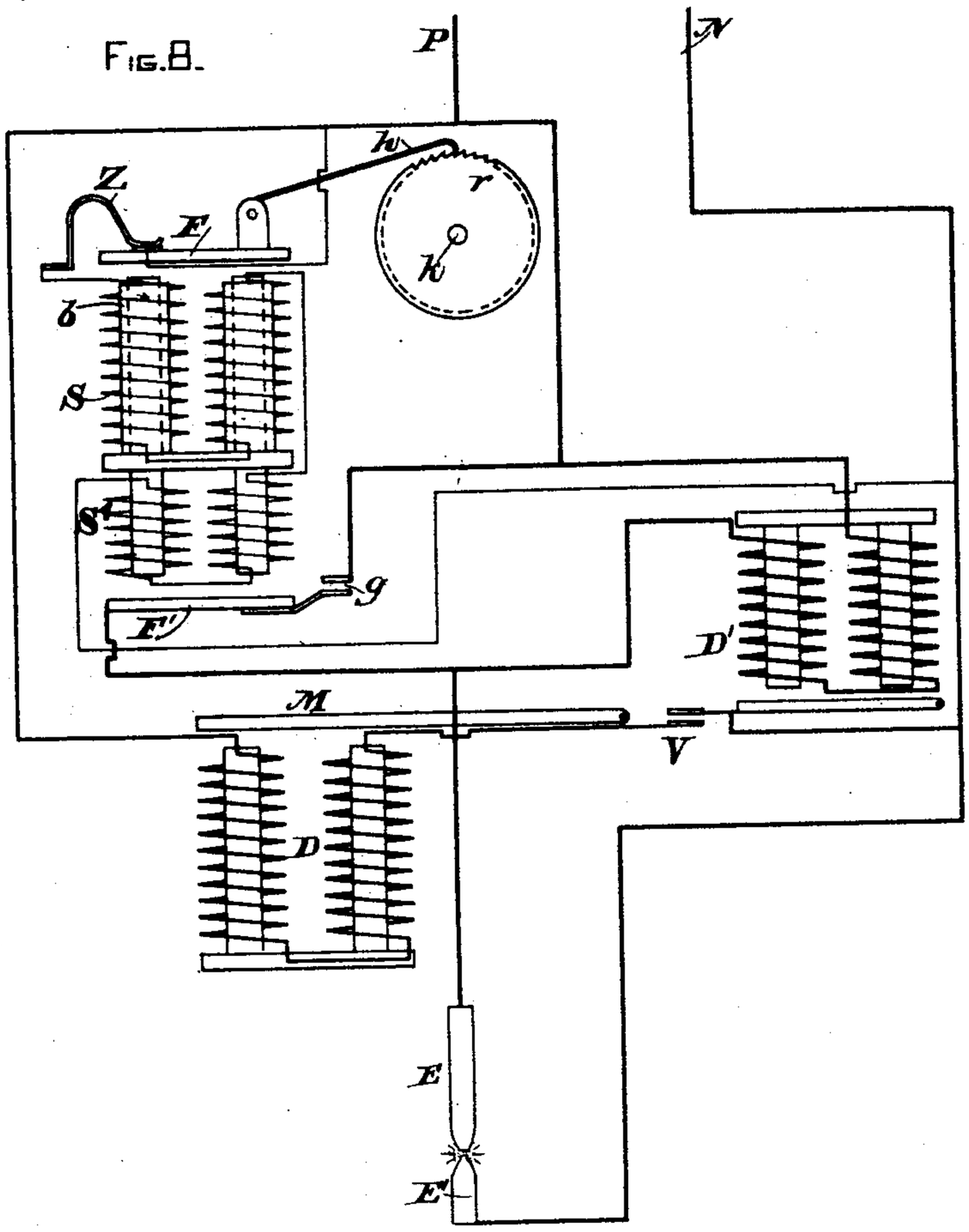


FIG. 9.

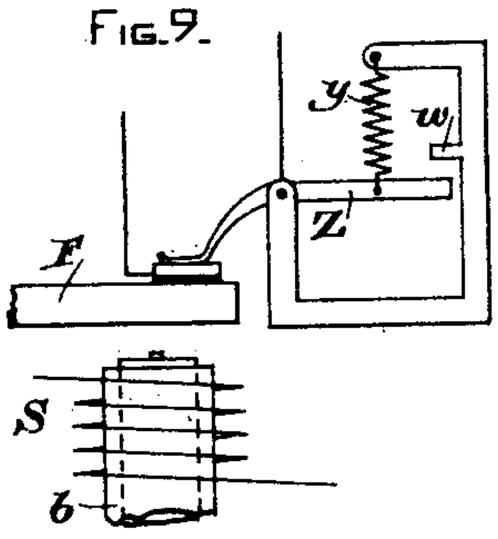
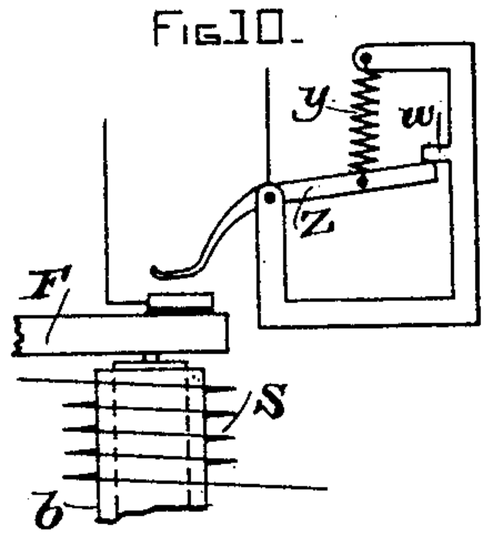


FIG. 10.



WITNESSES-

A. F. Macdonald.

A. E. Cline

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Attys.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 458,025, dated August 18, 1891.

Application filed April 27, 1891. Serial No. 390,560. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex and State of Massachusetts, have invented a certain new and useful Improvement in Electric-Arc Lamps, of which the following is a specification.

The present invention relates to the construction of arc lamps, and is particularly directed toward securing a refined and positive feeding motion for the carbons, together with the features of compactness and moderate length in the lamp structure itself.

Modifications in the construction are made, as will be explained in the following description to adapt the lamp for use on currents of constant potential or in series with other lamps on a constant-current circuit.

Reference will be had to the accompanying drawings in explaining the invention.

Figure 1 is an elevation of an arc lamp embodying my present improvements. Fig. 2 is another view taken at right angles to that of Fig. 1, showing other parts in addition. Fig. 3 shows the feeding devices separately. Fig. 4 shows the same in connection with the starting or arc-forming devices. Figs. 5 and 6 shows details. Figs. 7 and 8 are diagrams showing the circuit connections, respectively, for constant-potential and constant-current systems. Figs. 9 and 10 show a modification of a detail. Fig. 11 is an axial section through the carbon-supporting wheel and connected parts.

The terminals of the lamp are marked + and --, or P and N. The mechanism of the lamp is substantially inclosed by the upper plate Q and the supporting-plate Q', together with a cylindrical shell fitting over them. The side rods R R' are carried by the general base-plate, which upholds the mechanism of the lamp, and they extend downward to the length required for the support of the piece Y, which is a yoke connecting the two rods R R', and having lugs that are also carried thereon for sustaining the lower-carbon dish B, which serves as the support for the lower carbon E', through suitable clamping and holding devices, such as are ordinarily used. One of the side rods R R', which are preferably made of tubes, carries an insulated conductor connecting with the lower-carbon dish B at one end and at the other to the negative electrode carried upon the frame of the lamp above. The upper carbon E is carried upon the carbon-holder, in turn attached to the center of a guide-frame G G, sliding up and down between the side guides R R'. This guide-frame G G, with the upper-carbon holder, is attached by a strip or tape of metal or a metal ribbon T to a drum W, upon which said strip winds or unwinds, as the case may be. This tape forms a flexible support for the carbon. The drum W is mounted upon an axis carried by a lever L. (See Figs. 2 and 4.) On the same axis as the drum W is a worm-wheel U, which, for the feeding operation and unwinding of the ribbon T, is moved by a screw or worm K, carried on a shaft *k*, which bears a ratchet-wheel *r*, which ratchet-wheel is impelled tooth by tooth by a pawl *h*, engaging in its teeth and causing its rotation. The shaft *k* is journaled at one end in the fixed frame at *k'*, and at the other end it rests in a slot k^2, and is held down therein by a spring S^2, so that it may be lifted against the action of said spring. The pawl *h* is moved intermittently by the vibration of an armature F, to which it is pivoted, which armature is attracted intermittently by an electro-magnet S. (See Figs. 1 and 3.) Said electro-magnet is in a derived circuit around the arc at E E', the circuit being completed through a contact or rheotomic circuit-breaker constituted by the armature F and a suitably-constructed spring Z. The movement of the armature F toward the magnet-pole breaks the circuit of the magnet itself, and this is followed by a return of the armature upward under the action of the retractive spring S^3, restoring contact with the spring Z and putting the magnet S into action again as often as may be necessary. There are certain peculiar features, however, about this action which enables me to secure the requisite range of motion in the pawl *h*, instead of a rapid, tremulous, and uncertain feeding action which would otherwise be likely to be obtained. This will be explained later.

D is the separating or arc-forming magnet, whose operation can best be explained by reference to Figs. 2 and 4. The electro-magnet

D is shown as provided with conoidal or paraboloidal poles, which attract a perforated armature M. This armature is borne upon the lever L, which is pivoted at O, and is retracted by a spring S′, or, rather, by two springs S′, pulling in the same direction and subject to adjustment by adjusting devices *s*, one end of each spring being suitably attached to a fixed support. This axis of the drum W, upon the outside periphery of which the tape T is wound, is borne upon the lever L, so that as such armature M rises and falls the wheel or drum W will rise and fall, and if held from rotation will lift the carbon E and form the arc when it rises.

The drum W is shown in Fig. 5 constructed with a spiral coiled spring I inside it, so arranged that when the tape T is pulled downward under the weight of the frame G G and carbon E it rotates so as to coil up the spring I, the weight of the parts being sufficient to do this; but when the frame G G is manually lifted the spring I then asserts itself and winds the tape T on the exterior of the drum. To permit these actions the connection of the drum to the worm-wheel is not positive, but through an intermediate pawl and ratchet at *t*, Fig. 2, which makes the action positive in the downward direction of the tape and gives a free release of the drum in the winding action of the tape T. The tape-wheel and ratchet-wheel are fast on the axis or shaft shown in Fig. 11, while the worm-wheel is loose on said axis and carries the pawl engaging with the ratchet-wheel, so that when the worm-wheel is in engagement with the worm K the pawl holds the carbon-support from downward movement, but allows its free upward movement. This pawl-and-ratchet connection may be replaced by any well-known equivalent. The worm K bears on the wheel U, as stated, and causes the rotation of the drum W when the ratchet-wheel *r* is operated by the pawl *h* in causing a descent of the carbon.

The operation is as follows: Assuming the lamp to be arranged in a branch circuit from a constant-potential circuit with a sluggish resistance in circuit, as shown in Fig. 7, the magnet D, Fig. 2, may be in shunt around the lamp, and it will then be energized vigorously to pull down the armature M, which will lower the drum W and likewise the tape T and cause the carbons, which up to this time were separated, to be contacted. If this lowering action is not sufficient to contact them, it proceeds, so as to drop the drum W and the worm-wheel U from the screw or worm K and release them from engagement, at which time the drum W is perfectly free to turn to allow the tape and upper carbon to descend to the extent necessary to produce contact. On a contact of the carbons the potential around the magnet D falls, and it then relaxes its armature M, retraction by the spring S′ occurs, the tape T and drum W are lifted, and a separation or arc is the result. From this time as the carbons consume the feeding action is taken care of by the magnet S acting on the pawl *h*.

The feeding mechanism is shown separately in Fig. 3. The electro-magnet S, wound in a derived circuit which is only completed when the spring Z touches the contact-piece borne on the armature F, is also encircled by a closed winding or copper band either outside or inside of the ordinary wire winding. This copper band or closed circuit surrounding the core of the magnet, which is shown at *b*, Fig. 6, is a copper tape underlying the winding and surrounding the core F, so as to retard the acquirement and discharge of the magnetism of the core and so render the magnet's action quite sluggish, and at the same time to increase the range of motion of the armature F in approaching and receding from the magnet. The attraction, in other words, does not cease upon opening of the contact between Z and the contact on the armature, but goes on for a short interval while the magnet is losing its magnetism, being sustained in part by the copper band. Neither does the retraction cease at the moment the armature F again makes contact with the spring Z; but the spring Z is bent, being made limber for the purpose, and the armature does not again return until it is accomplished in the sluggish manner due to its magnetic state. This arrangement insures a free play of the armature within a considerable range, and enough, therefore, to cause the pawl *h*, which is hinged to it, to take a tooth at each to-and-fro motion. The retracting-spring is S^3 and the adjustment a^2, the ratchet-wheel *r*, bearing the screw, being set in motion and the adjustment being made such that the feeding only takes place when the strength of the magnet S is great enough, owing to an increase of length of arc, to require a feed, which feed then takes place by intermittent vibrations of the pawl *h* until the arc is properly shortened. An exceedingly delicate and positive feed is in this manner obtained.

In Fig. 4 are shown in outline the arrangements particularly concerned in effecting the lift or separation of the upper carbon from the lower, and also the free release—in other words, the arc-forming mechanism. Here the magnet D is shown with the armature M down, in which case the lever L is at its lowest point and the spring which retracts the armature M is now strained as much as it will be; but the amount can be adjusted by a screw *a*. The pivot O of the lever L is carried on the frame, and therefore keeps a fixed position. The pivot of the drum W and the feed-wheel or worm-wheel U is carried on the lever L and is now in its lowest position. The worm K is disengaged from the worm-wheel on account of the fact that the lowering of the lever L drops it away, as the shaft on which the worm K is carried cannot follow the whole distance, owing to the limitations imposed by its bearings, the bearing at one end, where the ratchet-disk or

wheel r is placed, being fixed in the frame and the other bearing being in the notch or slotted extension of the lever L, the spring S^2 holding the shaft down in the slot, as shown in Fig. 1. It will be seen that in the position of the parts in Fig. 4 the ribbon T around the drum can be unwound by the weight of the frame or guides G G, Fig. 1, without being restrained in this respect by the engagement of the worm-wheel U with the endless screw K, but that on the release of the armature M, as before described, the engagement takes place, and the drum W being prevented from rotating the lever L, under the action of the retracting-spring, lifts the whole mechanism and the ribbon T, and, separating the upper carbon from the lower, forms the arc. As before described, the drum W has a spring I, Fig. 5, inclosed in it, which tends to counteract or balance the weight of the frame G G; but it is insufficient in its coiling action to do this. It is, however, powerful enough in its coiling action to rewind the metallic ribbon T upon the drum when by any reason the frame G G is lifted, so that it at all times keeps the ribbon T taut.

Fig. 7 shows at m m' constant-potential mains with a branch through the arc-lamp mechanism. A resistance X for a sluggishing action is interposed, as usual. The connections of the magnet D are seen to be in shunt to the carbon rod E E′. The feeding-magnet S is also shown to be in shunt to the carbons, and this shunt is made through the armature F and the spring Z, as before described, and interrupted when the armature descends toward the magnet in operating the pawl h for feeding.

The lamp, as described, is adapted to operate upon the constant-potential circuits. Where it is desired to operate the lamp upon constant-current circuits in series with other lamps or other resistances, the arrangement is modified to embody the parts shown in Fig. 8. Here the feeding mechanism and the separating mechanism contrivances are identical with those already described in connection with Figs. 1 and 2; but the electrical arrangements will be modified, as will be described. At P and N are supposed to be connections which represent the lamp-terminals, allowing it to be inserted into a series circuit. As before, the magnet S, which has a copper sheathing for rendering its action deliberate or slow, is provided for controlling the feed mechanism consisting of the armature F, as before, with the pawl h, ratchet-wheel r, &c. The spring at Z performs the same function as it did in the mechanism of the prior figures and in identically the same way. In addition, however, to the magnet S, an extension of its cores forms a secondary shunt-magnet S^4, wound with wire in the same circuit or in a separate shunt-circuit around the magnet S. This magnet serves to actuate the armature F′ to close a contact at g whenever the arc between the carbons E E′ is too long or of such length as to require a lamp to be cut out. It is therefore a cut-out and extension of the feeding-magnet S. The magnet D, instead of being put in a high-resistance derived or shunt circuit, as in Fig. 7, is in this case put in a comparatively low-resistance branch around the arc, which, leaving the terminal P, passes through the magnet-coils of the magnet D, through the contact at V, and to N. The contact at V at the start is closed, but subject to be opened on the energizing of the magnet D′, which is direct connection from the terminal P to the upper carbon E, as shown, and the contact at g, actuated by the armature F′, is a shunt of low resistance around the magnet D′. As before, the carbons will be separated at the start by the armature M being retracted from the magnet D. The contact at g would be opened. The contact Z would be closed. On passage of current it would not go through the carbons on account of their separation, but would take the path from P, through the magnet-coils D, through the contact V to N. This would energize the magnet D, attracting the armature M, bringing the carbons in contact and cause a diversion of current through the magnet D′ and through the carbons in circuit therewith, which magnet D′, attracting its armature, would open contact V, de-energize magnet D, release armature M, allow the carbons to be separated by the retractile spring S′, Fig. 2, establishing the arc, the magnet D′ continuously maintaining the contact V open during normal operation. As the arc lengthens the magnet S increases in strength, moves its armature F toward the pawl h, opens contact with spring Z, and vibrates the armature F accordingly, as before described, to secure the action of a slow and very definite feeding of the lamp as the carbons consume. If this should cease from any cause, an extra power is given to the accessory cut-out magnet S^4 in derived circuit, the armature of which magnet F′ has up to this time been unattracted, being adjusted to remain so unattracted until such abnormal increase of power of the magnet S takes place. The armature F′, being then attracted, closes contact g, when the magnet D′ drops its armature and closes the contact V, puts the magnet D into circuit around the carbon arc at E E′, and effectually shunts the arc when it is too long for any reason, keeping the circuit on which other lamps may be running closed and complete.

The slow-acting rheotome is an important feature and may be advantageously used in many other connections than that here shown—for example, in electric bells and similar devices. A modification of the rheotomic contact is shown in Figs. 9 and 10, where the contact-piece Z is made in the form of a little lever, and, instead of being a spring itself, it is under the influence of the spring y y, which tends to pull the contact down by

pulling upon the short end of the lever and throwing it toward the stop *w* on the fixed portion of the supporting-frame. The contact is shown closed in Fig. 9, with the armature F retracted to the full amount. The magnet S will, if the arc resistance be sufficient, attract the armature F. When this occurs, the contact carried by the armature does not at once break connection with the piece Z, but only after the armature has moved a little distance. Neither does the magnet S immediately let go the armature and allow it to return the instant the contact is broken; but, owing to the copper band around the magnet-core and owing to the fact that the armature is approaching the magnet and getting into a stronger and stronger field, it may continue to be drawn in and down almost until it touches the magnet. The magnetism of the magnet S on the opening of the contacts mentioned begins to fall; but if the copper band is not too light or small it will not fall so rapidly as to counteract the increased force due to the approach of the armature. In a short time, however, the loss of magnetism releases the armature, and starting from its lowest position—for example, that of F, Fig. 10—it recedes rapidly and closes the contact with Z, but does not regain magnetism on the instant that such contact is closed on account of the sluggishing band acting sufficiently to allow the armature F to move farther away and strain the spring *y*, as in Fig. 9. By this time the magnetic strength has reached the normal for the current traversing its coils, and if this is sufficient the armature F will again move toward the magnet. It will be seen that by this arrangement I secure a considerable excursion or movement of the magnet-armature, such as fits it to operate the feeding mechanism or the pawl *h* on the ratchet-wheel *r*, which appears in the former figures. This effect supplants a rapid, ineffective, tremulous vibration such as would be obtained with ordinary electro-magnets and contact devices, and the motions of the armature F are made remarkably slow or deliberate, so to speak, and at the same time positive and of sufficient range to fully operate the pawl. As will be seen, the slow and extended action of the rheotome is secured both by the closed sheath and by the yielding contact.

In Fig. 1 are shown means for closing the globe by a readily-removable cap. Such means, while not of my invention and not herein claimed, may be briefly described as follows: Attached to the yoke Y is a tubular extension downward adapted to receive a surrounding sleeve provided with catches at k^3 k^3, which catches engage with projections from the yoke Y or from portions directly under it. The sleeve which slides from the downwardly-extending portion from Y carries an insulating-block, through which the screws J J pass and which screws serve to bind together the parts carried by the sleeve itself. A shallow dish C^2 C^2, made of glass, earthenware, or porcelain, is provided and carried by the sleeve slipped over the downwardly-extending tube from the yoke Y, and serves to cap or close the lower opening in the surrounding globe of glass C C of the lamp. It will thus be seen that by loosening the catches at k^3 k^3 and a partial rotation of the block through which the screws J J pass a release of the catches is effected, the whole lower portion, including the dish C^2 C^2, may be removed, thus leaving the opening in the globe C C open to facilitate manipulation of the lower-carbon holder, if desired.

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

1. The combination, in an arc lamp, of a rotary part supporting the upper carbon and pivoted in a lever, a starting-magnet acting on said lever to lower the carbon-support, a retractor to lift said lever to form the arc, and a magnet-actuating feeding mechanism connected to and operating the rotary part to gradually lower the carbon.

2. The combination, in an arc lamp, of a rotary support directly connected to and supporting the upper-carbon holder by a flexible connection, a lever in which said rotary support is pivoted, a magnet for lowering said lever, a retractor for raising it, and a feed-magnet and mechanism for actuating the rotary support.

3. An arc lamp having a rotary carbon-support, a lever in which said support is pivoted, a feeding-actuator for engaging with and rotating the carbon-support, and a starting-magnet with its armature directly connected to the carbon-support for directly controlling the same and for also effecting the engagement and disengagement of the carbon-support and the feeding-actuator.

4. The combination, in an arc lamp, of a rotary winding-drum having the upper carbon attached thereto by a flexible winding connection, a lever carrying said drum, a worm-wheel operatively connected to said drum, a feed-worm with which the worm-wheel may be lifted into engagement, and starting means for lowering and raising the drum-supporting lever, substantially as and for the purpose set forth.

5. A rheotomic circuit-breaker for arc lamps or electric apparatus, substantially as described, comprising a magnet surrounded by a low-resistance closed conductor, and an armature and stop having a yielding contact controlling the circuit of the magnet.

6. A feed mechanism for arc lamps, comprising a ratchet connected through intermediate devices to the carbon, a pawl engaging with said ratchet, and a magnet and armature for vibrating said pawl, the magnet having a retarding closed conductor around its conductor and having its circuit controlled by the armature.

7. An arc lamp having a rotary carbon-support, a lever in which said support is piv-

oted, a feeding-actuator for engaging with and rotating the carbon-support, and a magnet and retractor respectively operating to lower and raise the said lever and bring the rotary support out of or into engagement with the feeding-actuator.

8. The combination, in an arc lamp, of a rotary carbon-support, a lever in which said support is pivoted, a feeding-actuator having a yielding gear with which a gear on the rotary support is engaged or disengaged as the said support is raised or lowered, and a starting magnet and retractor for raising or lowering the lever and rotary support to engage it with or disengage it from the said yielding gear.

9. A feed mechanism for arc lamps, comprising a ratchet connected through intermediate devices to the carbon, a pawl engaging with said ratchet, and a magnet and armature for vibrating said pawl, the magnet having a retarding closed conductor around its conductor and having its circuit controlled by the armature through a yielding contact.

10. The combination of the shunt-magnet for actuating the feeding devices, the starting-magnet for lowering the carbons into contact, a cut-out magnet therefor in circuit with the carbons, and a shunt-magnet controlling a cut-out for said last-named magnet.

In testimony whereof I have hereto set my hand this 23d day of April, 1891.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
BENJAMIN B. HULL.