(No Model.)

3 Sheets—Sheet 1.

W. M. THOMAS.

ELECTRIC ARC LAMP.

No. 283,042. Patented Aug. 14, 1883.

Fig. 1.

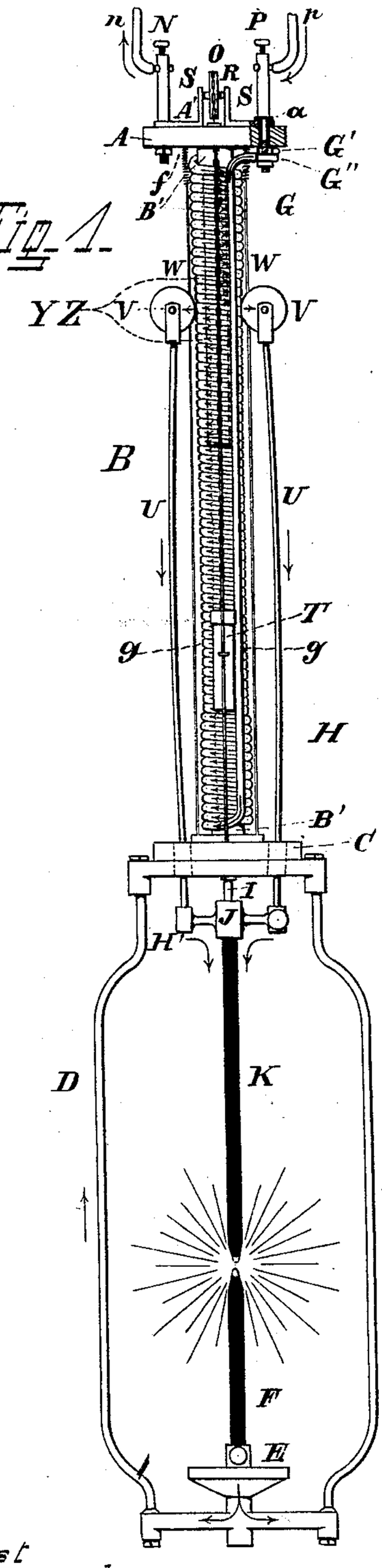


Fig. 2.

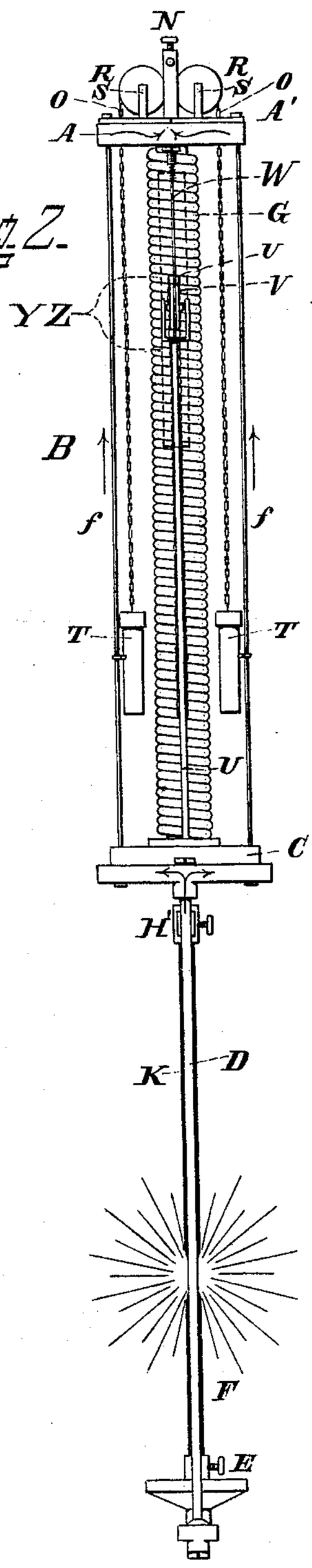
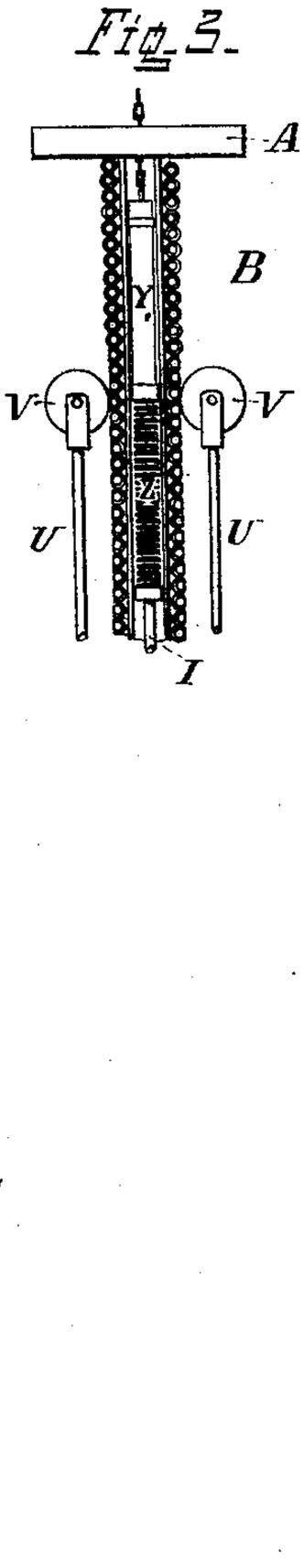


Fig. 3.



Attest
Carl Spengel
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by Knight Bros Atty's.

(No Model.)

3 Sheets—Sheet 2.

W. M. THOMAS.

ELECTRIC ARC LAMP.

No. 283,042. Patented Aug. 14, 1883.

Fig. 4.

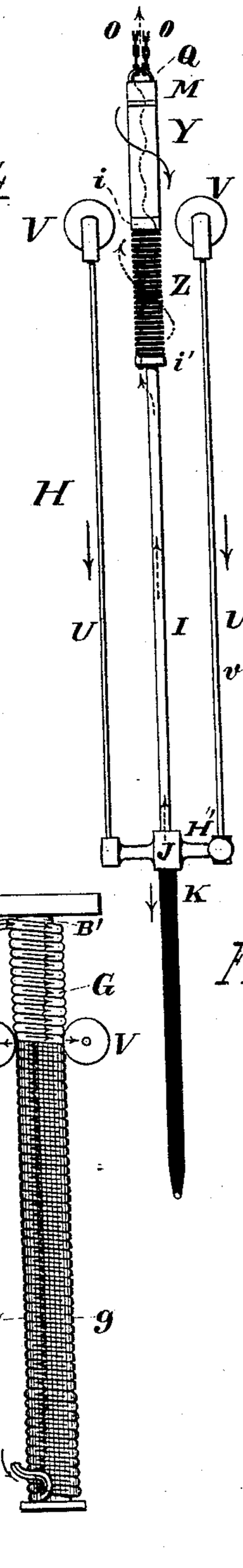

Fig. 5.

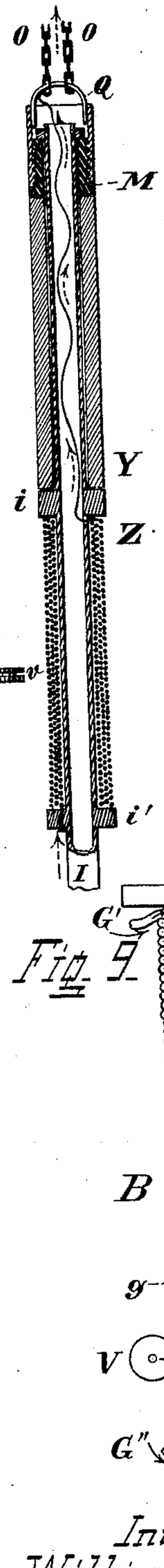

Fig. 6.

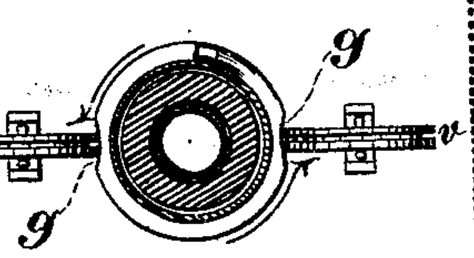

Fig. 7.

Fig. 8.

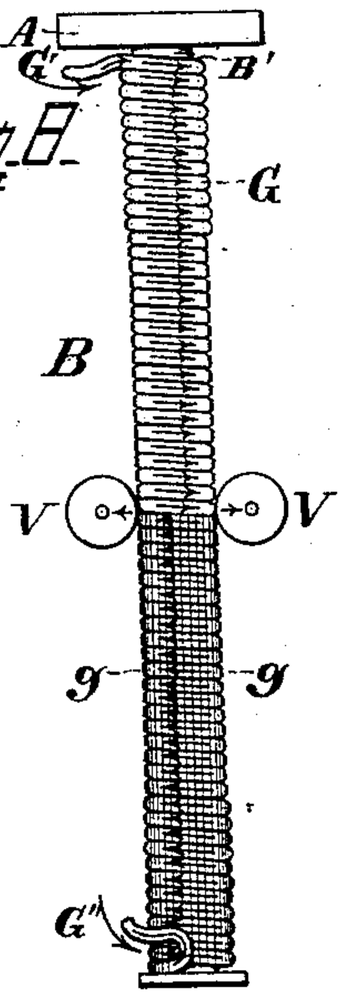

Fig. 9.

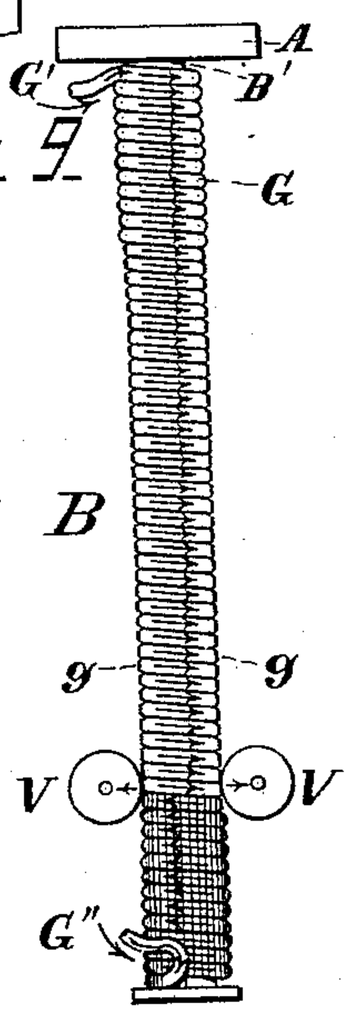

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Fig. 10.

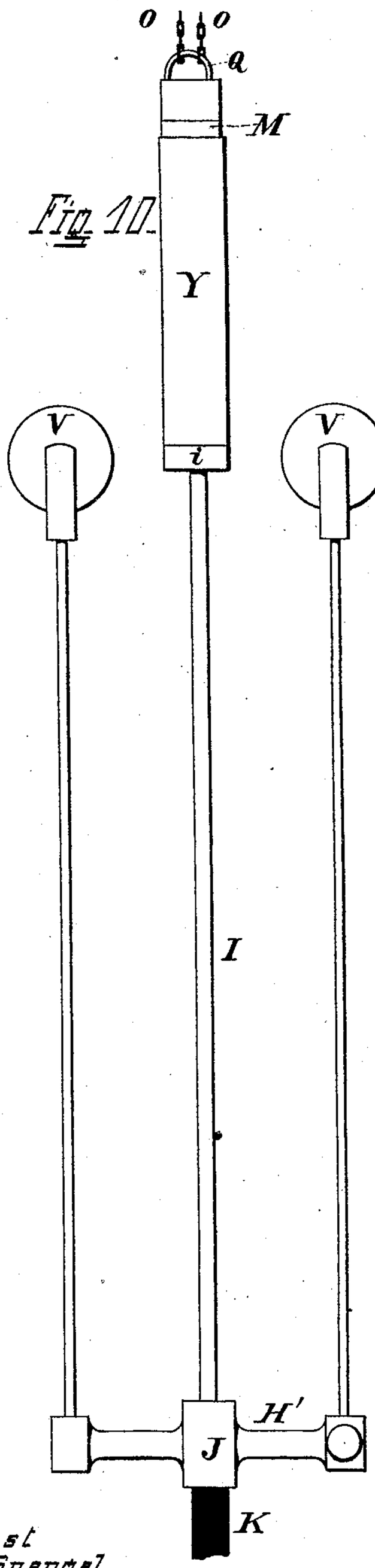
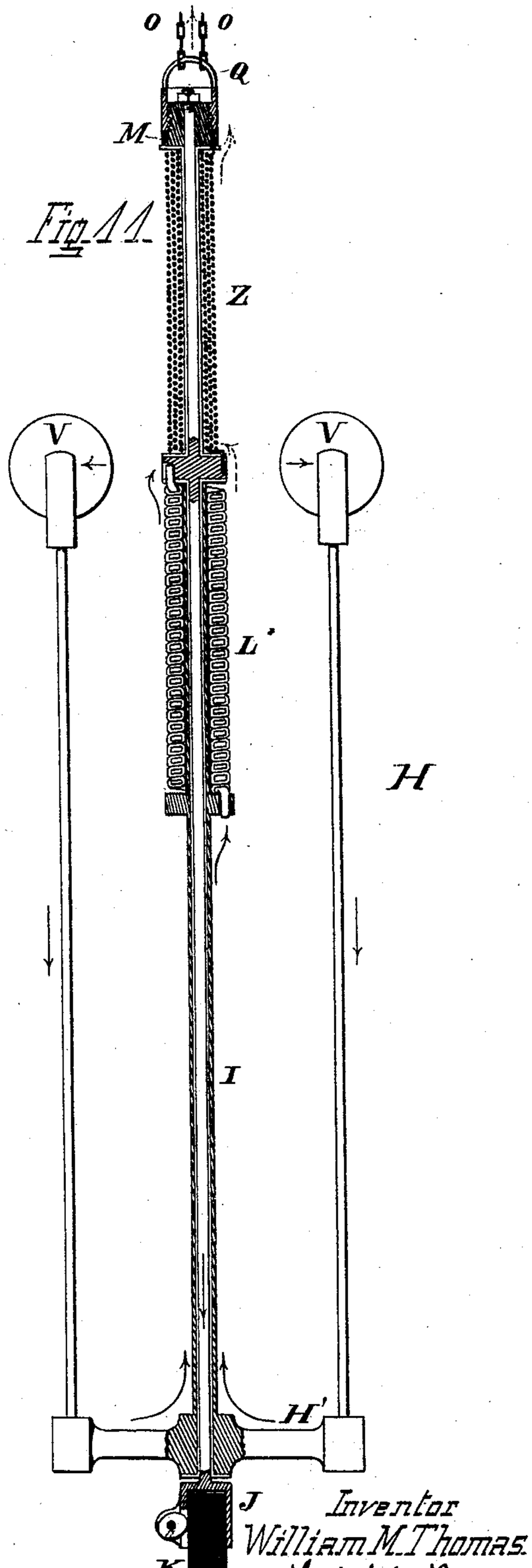


Fig. 11.



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Atty's.

UNITED STATES PATENT OFFICE.

WILLIAM M. THOMAS, OF CINCINNATI, OHIO, ASSIGNOR OF ONE-HALF TO SAMUEL W. SKINNER, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 283,042, dated August 14, 1883.

Application filed December 1, 1882. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM M. THOMAS, of Cincinnati, Hamilton county, Ohio, have invented a new and useful Improvement in Regulators for Electric-Arc Lamps, of which the following is a specification.

My invention relates to improvements in those electric-arc lamps whose electrodes are maintained at proper polar separation by direct attachment of one of them to a soft-iron armature or suction-core (or its equivalent solenoid) suspended within a helix in the arc-circuit; and my invention is more especially designed for securing illuminating equilbrium among two or more such lamps employed "in series."

The prime helix.—In my present invention I employ a single-layer helix having one or more bared tracks for the traverse of as many shifting contact-wheels, which have integral attachment to both armature and electrode, and which constitute part of the electric conduit to the latter, similar to the like parts described in my patents numbered, respectively, 253,322, 263,246, and 263,247, to which reference may be made for more minute description of whatever my said devices possess in common; but whereas in said previous patents the current entered the prime helix at one end only and then traveled in a single stream to the contact-wheels, leaving the entire lower part of the helix out of field, in my present invention the initial current, being divided and entering simultaneously both upper and lower extremities of the prime helix in multiple connection, one branch current flowing down that portion of the prime helix which is above the—for the time being—place of wheel-contact, and the other branch current flowing up the remaining portion, and the two currents reuniting at said place of contact, it follows that the helix is constantly utilized throughout its whole extent, and that in a twofold capacity, as will shortly appear.

The armature.—Mechanically attached to the carbon-carrier coincident with the prime helix's geometrical axis is a soft-iron suction-core, preferably tubular, and which, in association with the described coacting parts, constitutes the normal regulator of arc-distance. For lamps to be used in series there is associated with the soft-iron core a special regulating-member consisting of a high-resistance helix that shunts the arc, and which is brought into activity on any excess above normal of electrode separation and in proportion to such excess and in mechanical opposition to the core-suction. The thus associated core and shunt are known in this specification as the "duplex armature." The impact-level of the contact-wheels and the line of separation of the two armature-members coincide with a constantly-shifting horizontal plane, whose position at any given instant determines the level of common exit of the prime helix's two oppositely-directed currents, and consequently the portions of the prime helix which these currents, respectively, for the time being occupy.

Briefly stated, my regulator comprises a prime helix which, as already intimated, receives the electric current at both ends in two separate and oppositely-flowing streamlets, which, reuniting, escape at the same shifting-level through bared tracks on the helix's periphery into an oscillating member, of which the positive carbon forms an integral part, the vicissitudes of arc distance being automatically corrected by the perturbations of this oscillating member through purely electro-magnetic agencies in both the upward and the downward directions, the downward perturbations gradually prevailing as the carbons wear away. Like the forms described in my above-cited patents, the present form permits the use of carbons of any desired length, limited only by that of the prime helix, which may be of any convenient dimensions.

In the accompanying drawings, Figures 1 and 2 are respectively a front and a side elevation, of a lamp embodying my improvements. Fig. 3 shows the position of the oscillating member within the helix at insertion of a carbon. Fig. 4 shows the oscillating member detached. Fig. 5 is an axial section of my duplex armature, together with a portion of the supporting-stem. Fig. 6 is a transverse section at the plane of impact of the contact-wheels. Figs. 7, 8, and 9 are ideal illustrations of the relative actions of the prime helix

and contact-wheels. Fig. 10 shows the form of my oscillating member employed for isolated lamps. Fig. 11 represents, by axial section, a modification of my compound or duplex armature.

A represents a plate or collar of vulcanite or other suitable non-conducting material.

P and N are binding-posts for the wires *p* and *n*, which respectively convey the entering and departing currents. Both binding-posts are projections of a brass base, A′, which is fastened to collar A. Post N has direct electrical communication with base A′ and with its hereinafter-described attachments. Post P is insulated from plate A′ by vulcanite bushing *a*.

Firmly secured to collar A, and depending therefrom, is a tube, B′, of brass or other non-magnetic substance, which tube constitutes the bobbin of my prime helix B, hereinafter described.

To the lower end of tube B′ is secured a vulcanite collar, C, from which rigidly depends a brass pendant, D, that supports and has electrical connection with the holder E of the negative electrode F, which may be of carbon, as shown, or of refractory metal. The negative electrode F has electrical connection D *f* A′ N with the exit-wire *n*. The bobbin B′ is wound from end to end with wrapped wire G, of half the transverse section of wire *p*, which, communicating by both ends, as at G′ and G″, with the positive post P, constitutes the prime helix B. The periphery of the thus formed prime helix B has one or more bared tracks *g*, for the traverse of the switch or contact-wheels of my "oscillating member" H, now to be described.

From mid-length of a horizontal brass bar H′, which carries a holder, J, for the positive electrode or carbon K, there extends vertically a (preferably tubular) brass rod or stem, I, forming part of my armature-support. This stem I carries upon a collar, *i*, a tubular cylinder or sleeve, Y, of soft iron.

The sleeve Y, known in this specification as the "suction-core," has a vulcanite cap, M, to whose bail Q are attached metallic suspenders or chains O, which, passing over sheaves R, journaled in bearings S upon base A′, terminate in weights T, that are guided to a vertical path by rods *f*, one or both of which may do duty as part of the current-exit, as indicated by arrows in Fig. 2.

Extending upward from the ends of bar H′ are springs U, in whose summits are journaled my switch or contact-wheels V, which occupy and traverse the bared tracks *g*, upon the prime helix's periphery. Said wheels V may have circumferential grooves *v* for guide-rods W.

The members H′, I, J, O, Q, R, S, U, V, *f*, N, and *n*, are all of brass or other non-magnetic metal, to enable their use as simple current-carriers.

Fig. 10 represents that form of my oscillating member whose armature consists of a simple suction-core, a form which suffices for the regulation of a single isolated lamp or for any number of lamps that have independent connection with the line-wire or with the generator.

For two or more lamps in series it is well known that there is required in addition to the ordinary suction-core a supplementary instrumentality which will operate to counteract such excessive action of the arc-widening functions of the core proper as would seriously weaken the series-current even to the possible extinction of the less mobile or weaker lamps thereof. Such instrumentality has generally included some form of high-resistance helical shunt, but one whose duty it has merely been, at abrupt and somewhat arbitrary intervals, to abandon the electrode to the action of its own gravity, or to spring force, for all of the feeding or protractile movements of the carbons, the electro-motive functions in that particular lamp being, for the time being, non-existent, and, so to speak, dead. Beside the large amount of current-force wasted in overcoming the considerable mechanical ponderosity of the electrodes and their adjuncts under this system of operation such expedients are amenable to the more serious objection of violent fluctuations inseparable from the use of such fast and loose machinery, however simple. These defects practical tests prove my electro-magnetic feed to have remedied.

The form of special or supplementary feed-regulator which, for series use, I prefer to associate with the already-described retractile regulator Y, is shown in Figs. 3 and 4, in which, beneath the soft-iron core Y, and in alignment with it, there rests upon collar *i*′ of said stem I a helix, Z, of wrapped wire, of higher resist- than that of the normal arc, and which on any excessive widening of the latter becomes energized and operates to shunt the same. The said helix Z, known in this specification as "the differential," is so wound as to be attracted by the lower and repelled by the upper current of the prime helix, and consequently operates when energized in direct opposition to the suction-core Y. The said differential has direct electrical connection below with electrode-carrier H′ of the oscillating member H, so as to tap the main current before reaching the arc and thus "shunt" or "short-circuit" the latter, and above through the hollow core Y with bail Q, and thence through the parts O, R, S, T, and N, with exit-wire *n*. The dotted lines Y Z in Figs. 1 and 2, and the strong lines Y Z in Fig. 3, indicate the uppermost position of the armature relatively to the prime helix. The part Y Z thus constructed I call "the compound or differential armature."

In the figures the paths of the direct and of the shunted currents are respectively indicated by strong and by broken arrows. By proper adjustment of the counterpoise my oscillating member, whether for isolated or series use, is so graduated as to weight that, on

insertion therein of a fresh carbon, the said oscillating member, (being then in its highest position relatively to the prime helix,) the weights T, together with the external portions of the chains O, allow said member, and the then interior portions of chain, preponderance just sufficient to close the electrodes when the lamp is cut out of circuit, and so that as the oscillating member descends, and at the same time suffers loss of weight by the wearing away of its carbon, the transfer of chain-weight from outside to inside exactly suffices to maintain the said approximate equilibrium. Except to secure electrode contact of a cut-out lamp, my oscillating member might be so counterpoised as to be absolutely devoid of virtual weight, because the exigencies of actual operation of my lamp demand neither weight nor spring nor other extrinsic force, both feed and retractile movements of the electrode being accomplished by the direct agency of the electro-magnetic forces alone.

It will be seen that each of the portions of prime helix respectively above and below the—for the time being—level of current-escape is the theater of two concurrently-shifting electro-magnetic forces relatively to the duplex armature—that is to say, there is in each portion of the prime helix an attractive force on one section of the armature and a repellent force on the other section, the two forces acting on one armature-section co-operating to retract and those on the other armature-section to protract ("feed") the carbon, the centers of energy of these forces all moving in company, now upward and now downward, with the relatively-varying forces of the direct and shunted currents, the downward shifts in the long run prevailing as the carbons wear away. It is then apparent that in the present device the entire prime helix is utilized in a twofold capacity, the repellent forces of one part coacting with the attractive forces of the other part on the same armature-section; or, in the single armature simply, in the isolated lamp form, Fig. 10. Only such excess of weight of the oscillating member over the counterpoise being allowed as insures electrode-contact on withdrawal of current, and the positive electrode having unbroken connection with such member, and in fact constituting an integral part of it, the entire actions both of feed and retraction are purely electro-magnetic, and quite independent of weights, springs, clutches, or like mechanical adjuncts, with a consequent marked gain in promptness, delicacy, and economy of current-force. This important regulation for series, which depends wholly on automatic control of the carbon-feed, and upon which the practicability of subdivision depends, is believed to be more perfectly attained by the electro-magnetic forces themselves, as in present invention, than by mechanical connections and disconnections for bringing into momentary action the force of gravity or of a spring.

The above-described preferred form of my invention may be modified in non-essential particulars. For example, my duplex armature may be formed as in Fig. 11, in which a solenoid, L, (which is in this form the lower element of the armature and which constitutes a part of the current-channel from the prime helix to the electrode,) is substituted for and discharges the functions of the suction-core, the helical shunt Z in this form being the upper element of the armature. In this modification the directions of convolutions of each respective element are such as to cause it to be repelled by that part of the prime helix which is nearest to and attracted by that most distant from it. By this means, although their position on the armature is reversed, the respective functions of my two armature-currents are identical with the corresponding members of my typical form, Figs. 3 and 4—that is to say, my solenoid performs the retractile and my differential, as before, the entire feeding duties of the regulator.

Another possible modification of my invention may combine with such a duplex-current prime helix an electrode with integrally-attached solenoid, the center of whose field of energy is normally coincident with the plane of confluence of the two helix-currents, said solenoid being either single for an isolated lamp or compound (in which a solenoid in the arc-circuit is concentric to an integrally-attached and mutually-shifting shunt-helix) for a series lamp.

One or more of the above modifications may be embodied in separate applications for patent, for which more specific descriptions are reserved.

I am aware that electric-arc-lamp regulators have been devised for single lamps in which a suction-core located in a main helix that has formed part of the arc-circuit has been so fastened to one of the carbons as to graduate or control a spring or gravity feed, and that such lamps have been adapted for series use by such a core or by an external armature, which has had clutch or like fast and loose attachment to the carbon, and been associated with a high-resistance shunt-helix, whose duty it has been, when the arc-distance has become excessive, to surrender the carbon to a spring or gravity feed, the electro-magnetic forces being for the instant, so to speak, dead. I therefore disclaim novelty in such cores, shunts, and prime helices, broadly considered. I have, however, no knowledge of pre-existence of a regulator in which the illuminative equilibrium of electric-arc lamps in series has been maintained by exclusively direct action of the electro-magnetic forces upon both the feed and retractile movements of the carbon.

I am also aware that electric-arc-lamp regulators have been devised in which a soft-iron core, (or two such cores integrally attached endwise,) having mechanical connection with one or both carbons, has been suspended within two oppositely-attracting helices, of which one

has been in the arc-circuit and the other in a shunt thereof; but such devices have been constituted differently to mine, notably in the fact that their centers of field energy have been fixed instead of being shiftable with the core or cores, which latter have been capable of a comparatively limited range of oscillation, necessitating either the use of short carbons or some kind of fast-and-loose connection with the same.

Whatever novel subject-matter I have set forth and not claimed or attempted to claim herein I have claimed or attempted to claim in other applications, or have reserved to be claimed in future original applications.

I claim as new and of my invention—

1. In an electric-arc lamp, the combination, with a suction-core or armature mechanically connected to the electrode, of a helix that receives two oppositely-directed branches of the arc-current supply, which, entering the helix at its respective ends, reunite at a shifting communication with the electrode, substantially as set forth.

2. In an electric-arc lamp, a prime helix, the extremities of which are connected with the same rheophore, and which has one or more bared tracks that are traversed by as many conductors mechanically connected to the suction-core and to one of the electrodes.

3. In an electric-arc lamp, a helix whose upper portion conveys a descending and whose lower portion conveys an ascending branch of the arc-current supply, in combination with an electrode having an integrally-attached soft-iron suction-core, which occupies and is subject to the inductive and attractive energies of said upper portion and to the concurrently-directed repellent energy of the lower portion of said helix, substantially as and for the purpose set forth.

4. In an electric-arc lamp, in series, the combination, with a duplex armature integrally attached to the electrode, of a prime helix in the arc-circuit, which is traversed by two oppositely-directed branches of the entering current, which exercise upwardly-directed attractive and repellent energies on one armature element and downwardly-directed attractive and repellent energies on the other armature element, substantially as and for the purposes set forth.

5. In an electric-arc-lamp regulator, in combination with an oscillating member, H, of which a suction core or armature, an electrode-holder, and one or more contact-wheels are integral parts, the prime helix B, having one or more bared tracks, which helix communicates at both ends with the current-supply, and at a shifting intermediate level through said track and wheels with the positive electrode, substantially as set forth.

6. An electric-arc-lamp regulator having a prime helix in the arc-circuit, which receives current at both ends in two separate and oppositely-flowing streams, and which discharges both streams at a variable level through one or more contact-wheels in said circuit that occupy bared tracks on the helix's periphery and have mechanical connection with a suction-core or armature of said helix and with the positive electrode, substantially as set forth.

7. In combination with a prime helix in the arc-circuit whose upper and lower portions are traversed by oppositely-directed branches of the current-supply, the duplex armature Y Z, integrally attached to the positive electrode and of which one member Y is subject to the combined upwardly-directed attractive and repellent forces of said helix portions, and of which the other member (which is a high-resistance helix that shunts the arc) is subject to the downwardly-directed attractive and repellent forces of said helix portions, substantially as set forth.

8. An electric-arc-lamp regulator in which a prime helix in the arc-circuit has electrical communication at both ends with the positive rheophore, and has one or more bared peripheral tracks, in combination with an oscillating member which consists of the following integrally-attached parts, to wit: positive electrode-holder H′, duplex armature Y Z, springs U, and the switch or contact wheels V, substantially as set forth.

9. In an electric-arc-lamp regulator the following elements, to wit: a prime helix in the arc-circuit which receives the current at both ends, which current traverses the respective portions of the helix in two oppositely-directed streams that escape at a variable level through one or more bared tracks, in the described combination with an oscillating member which comprises the following integrally-attached parts, namely: a carbon-carrier, which has mechanically attached to it one or more contact-wheels in arc-circuit, and which has, coincident with the prime helix's axis, a duplex armature whose members are attached endwise and consist, respectively, of a soft-iron tube or core and a helix of high resistance which shunts the arc.

10. In an electric-arc regulator, a prime helix in the arc-circuit wound and connected, as described, so as to receive the electric current at both ends in two separate and oppositely-flowing streams, which, reuniting, escape at the same shifting level through bared tracks on the helix's periphery into the oscillating member H, of which the positive carbon forms an integral part, substantially as and for the purpose set forth.

11. The combination of prime helix B, connected at both ends with the positive rheophore, and having shifting communication by its bared track *b* with the arc through oscillating member H, consisting of the following integrally-attached parts, to wit: the carbon-holder, contact-wheels, retractile core, and the differential shunt, which, tapping the carbon-holder above the arc, discharges through the counterpoise mechanism, substantially as set forth.

12. In a regulator for an electric-arc lamp, in series, the combination, with the prime helix B, of the electrode-carrier H′ J, having the integrally attached springs U, surmounted by contact-wheels V, and the stem I, which carries the two elements Y Z, of which element Y is a soft-iron upwardly attracted and repelled tubular core, located above the contact-wheel level, and of which element Z is a downwardly attracted and repelled high resistance-shunt helix, located below the wheel level, and whose lower end taps the current above the arc, while its upper end communicates through the core-orifice through bail Q, suspenders O, sheaves R, bearings S, plate A, and post N to the exit-wire *n*.

In testimony of which invention I hereunto set my hand.

WILLIAM M. THOMAS.

Witnesses:

GEO. H. KNIGHT,

SAML. S. CARPENTER.