(No Model.) 3 Sheets—Sheet 1.

# E. THOMSON & E. W. RICE.

## ELECTRIC ARC LAMP.

No. 440,662. Patented Nov. 18, 1890.

Fig. 1,

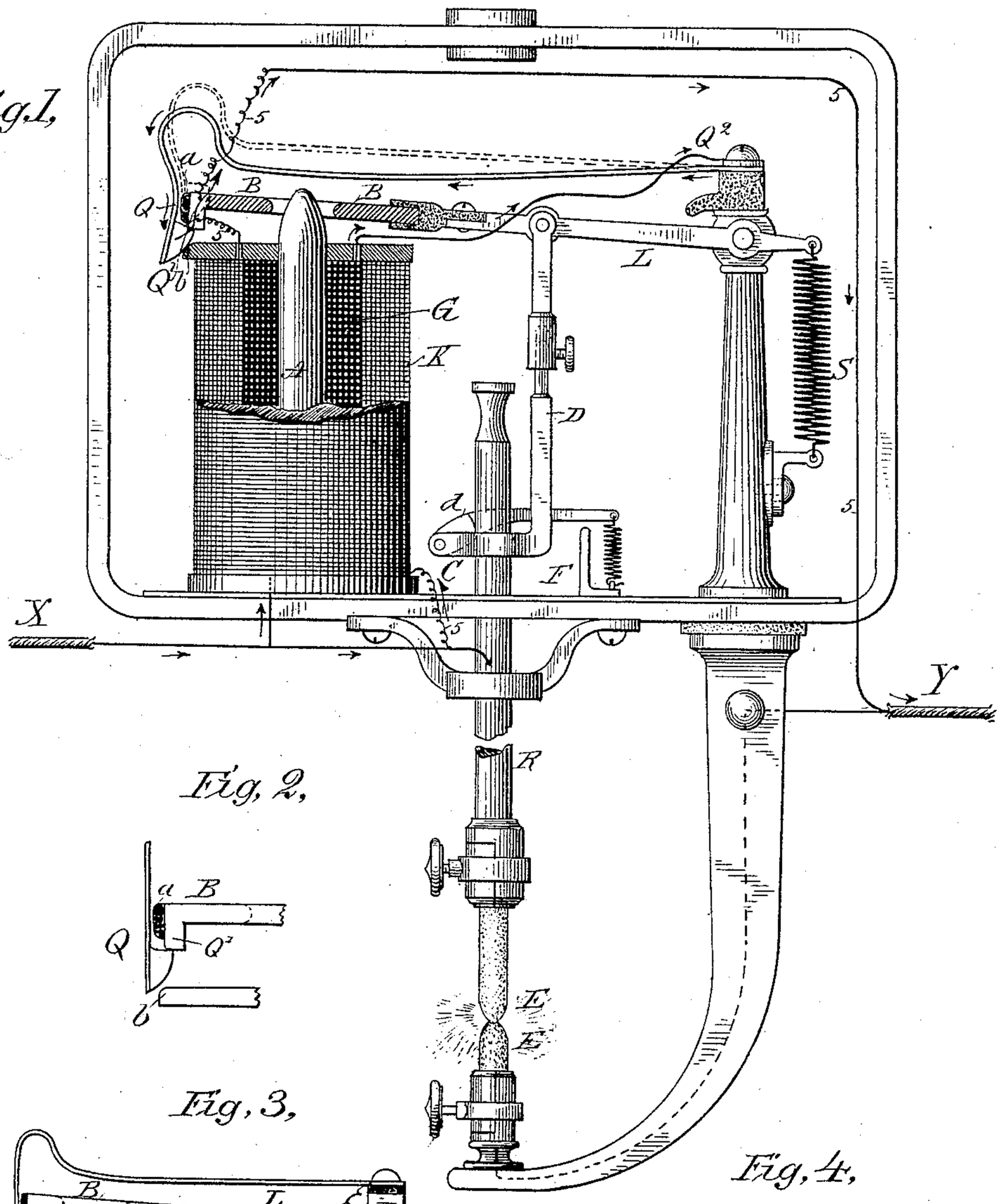



Fig. 2,




Fig. 3,

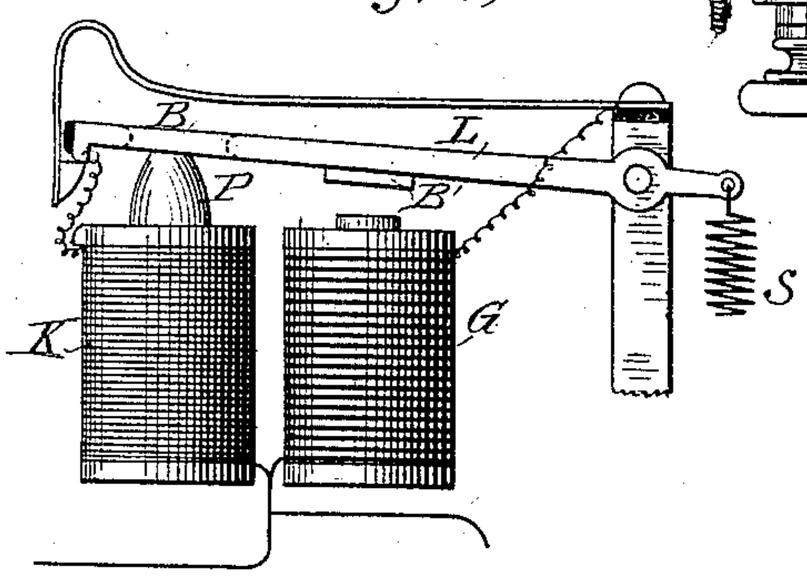
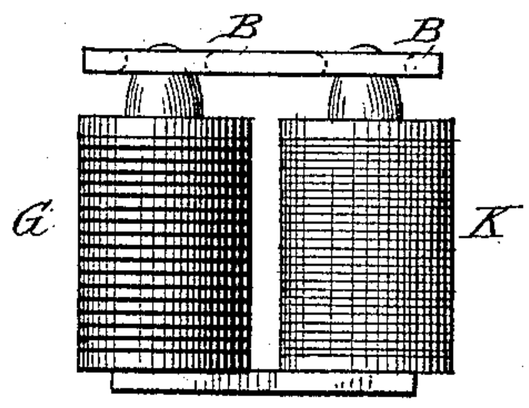



Fig. 4,

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E. W. Rice

By their Attorney: W. C. Townsend.

(No Model.) 3 Sheets—Sheet 2.

# E. THOMSON & E. W. RICE.

## ELECTRIC ARC LAMP.

No. 440,662. Patented Nov. 18, 1890.

Fig. 5

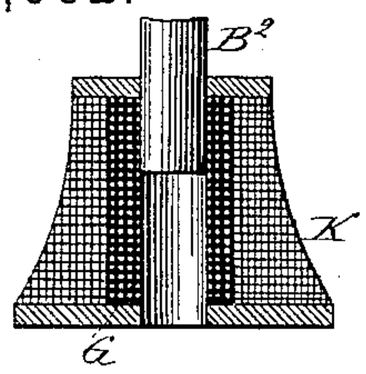



Fig. 7,

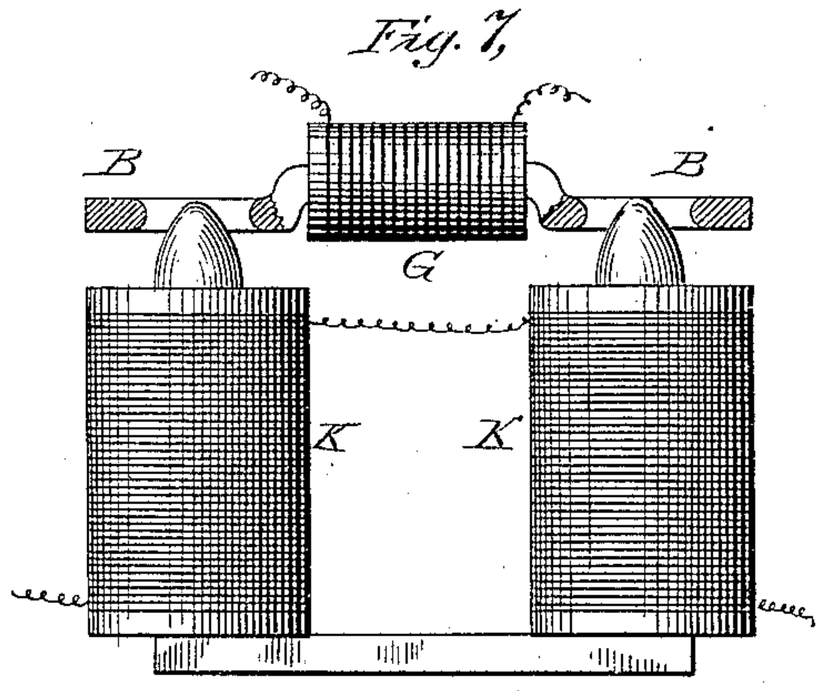



Fig. 6,

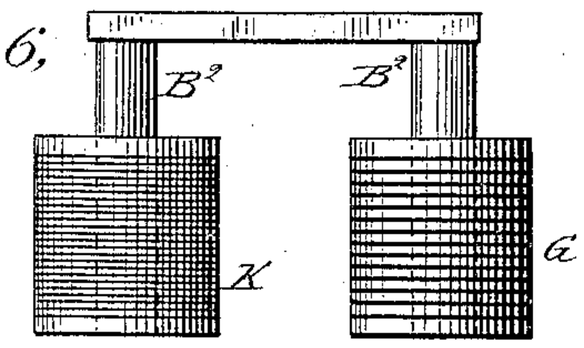



Fig. 8,

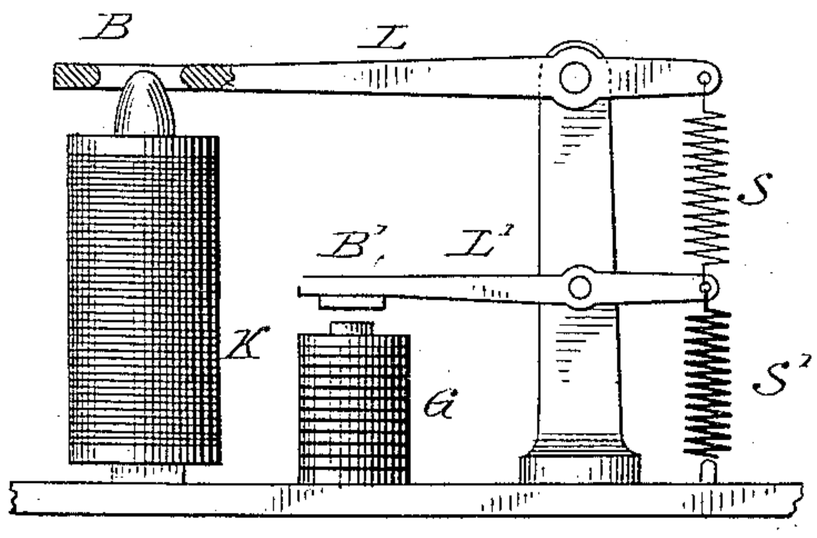



Fig. 9,

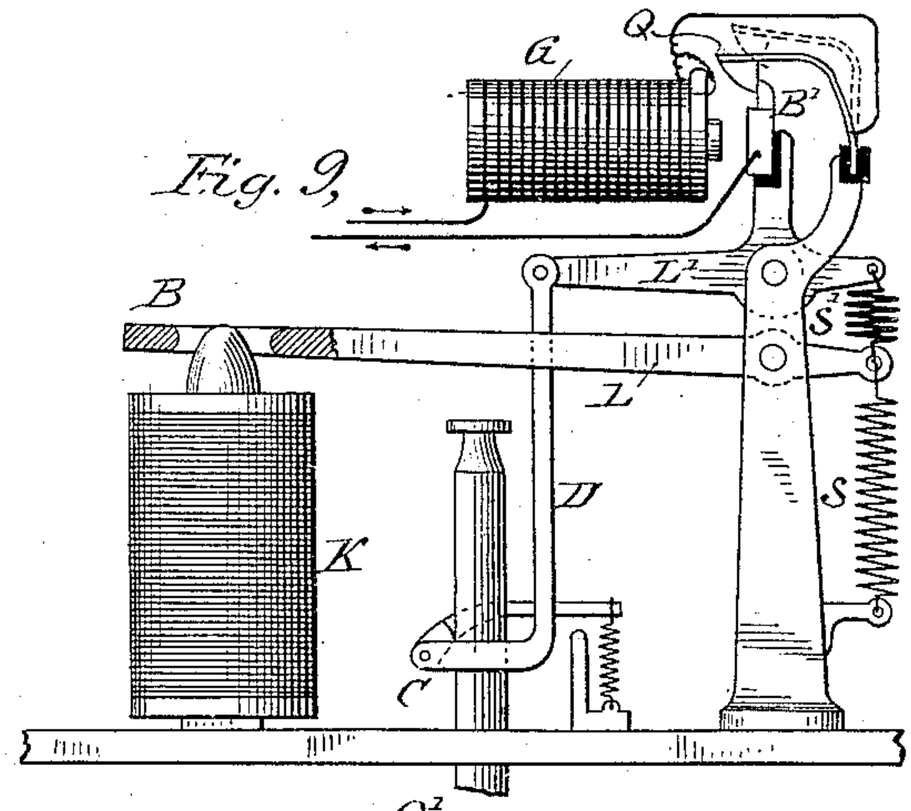



Fig. 10,

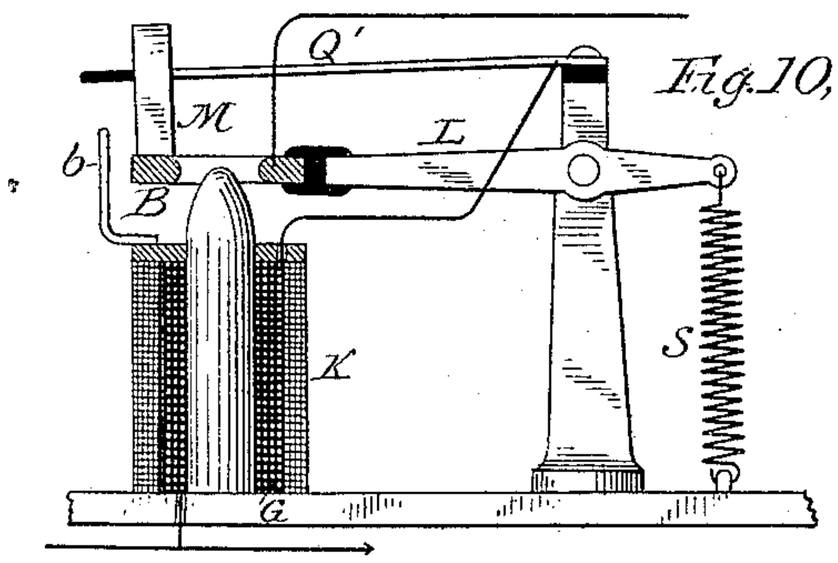



Fig. 11,

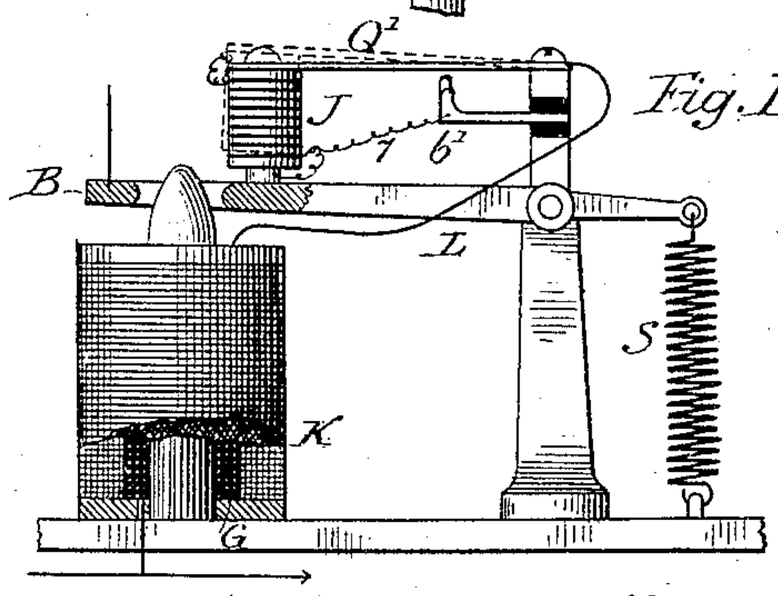



Fig. 12,

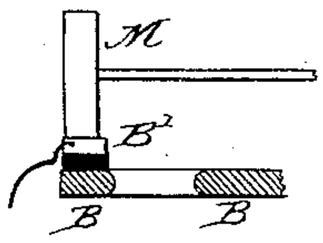
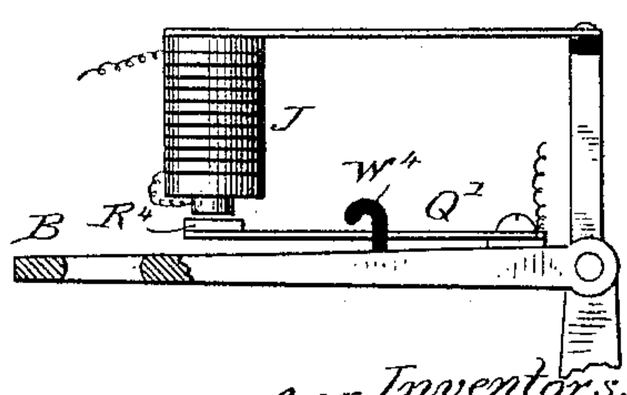



Fig. 13,

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# E. THOMSON & E. W. RICE.

## ELECTRIC ARC LAMP.

No. 440,662. Patented Nov. 18, 1890.

Fig. 14.

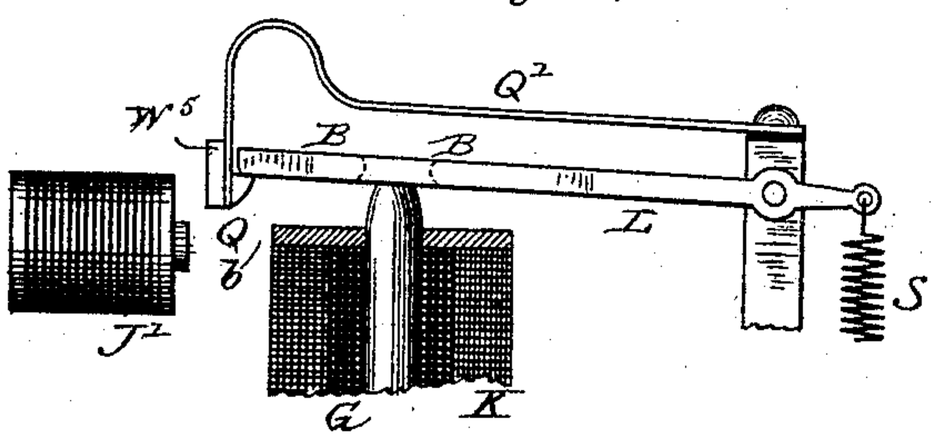



Fig. 15.

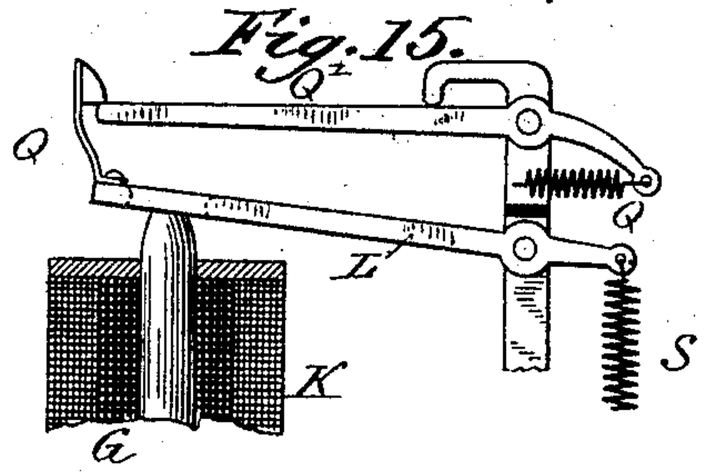



Fig. 16.

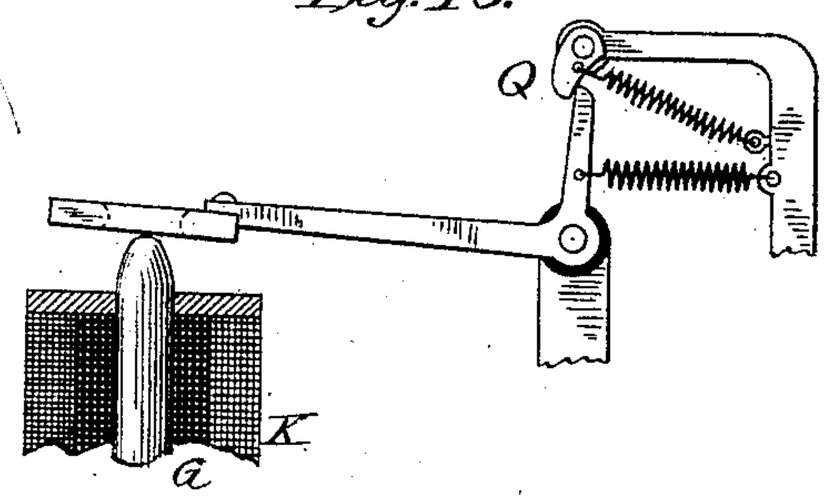



Fig. 17.

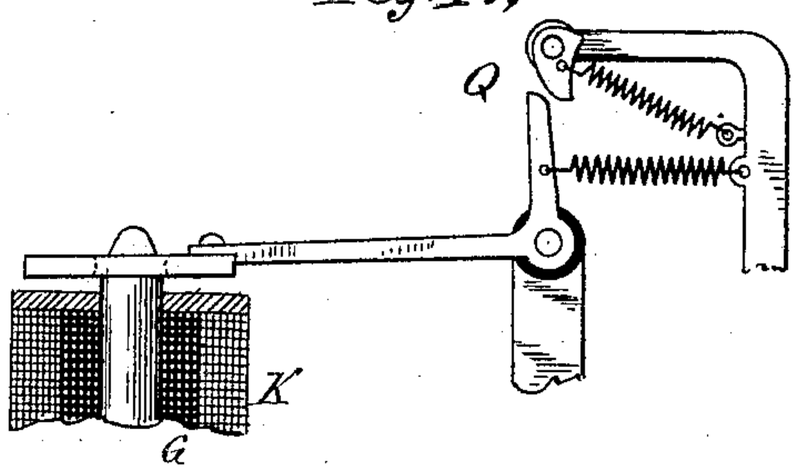



Fig. 18.

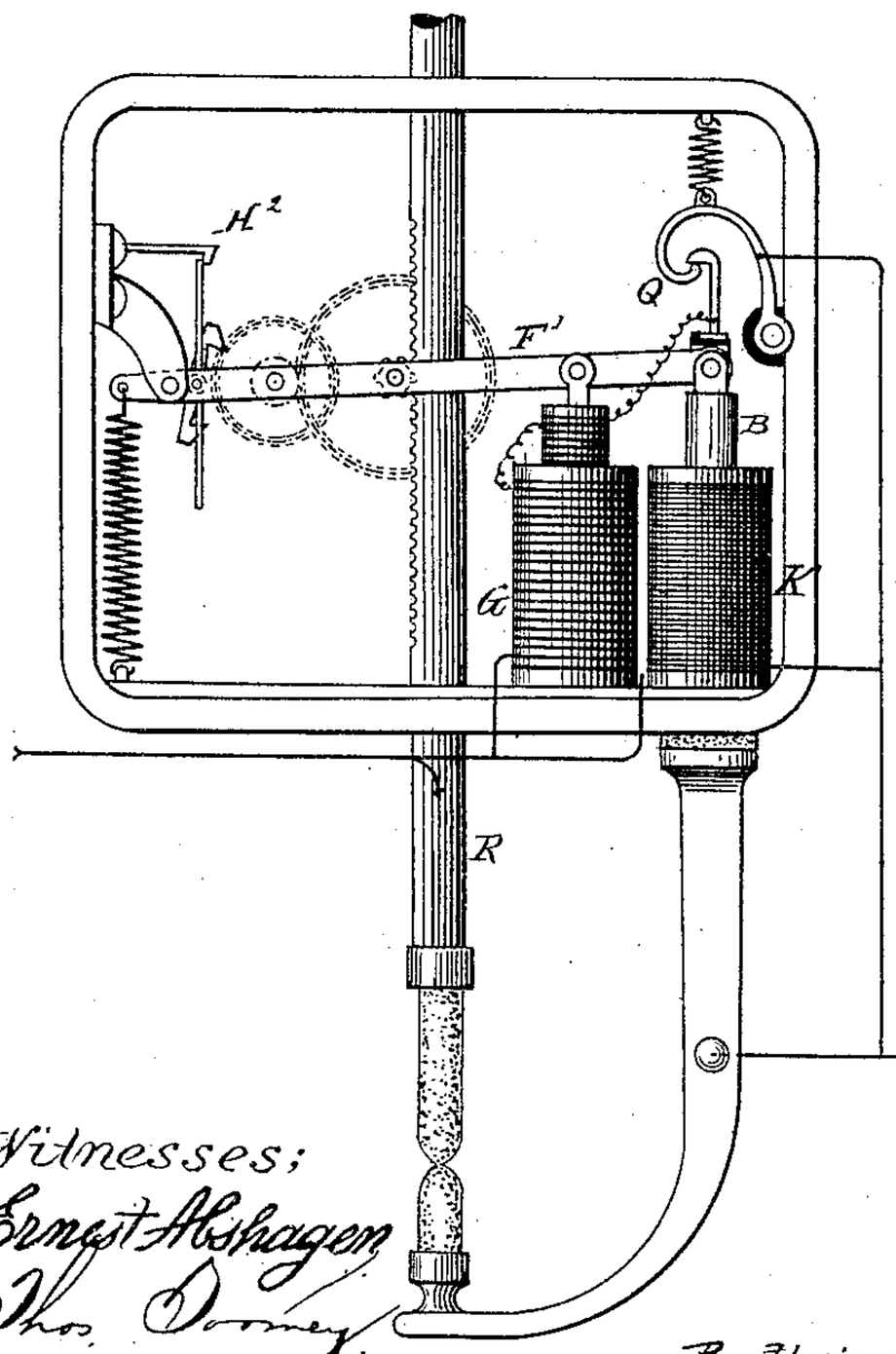
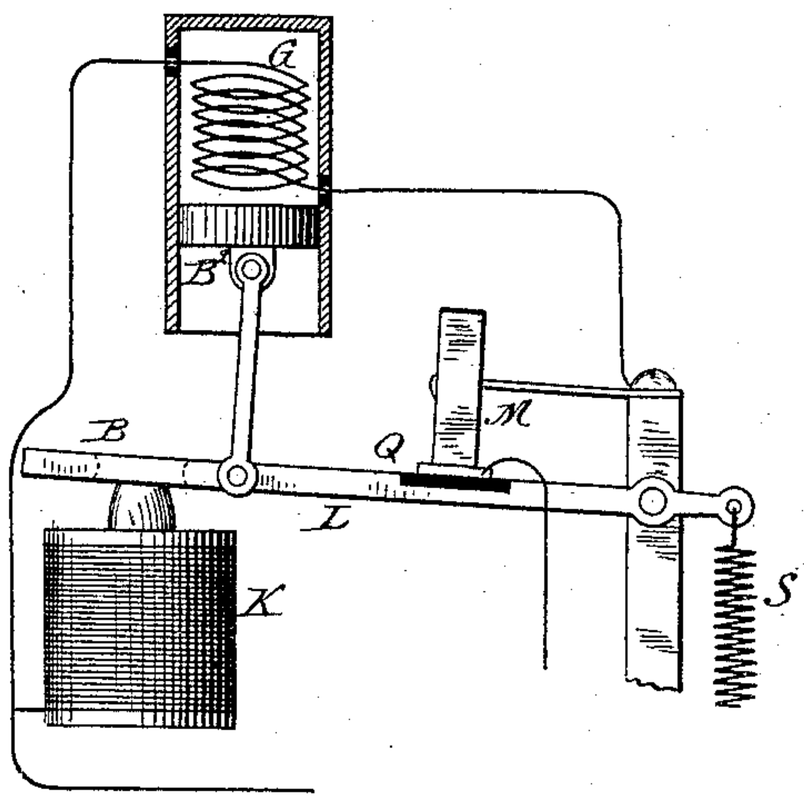



Fig. 19.




Witnesses;
Ernest Hopkagen
Thos. Dorney.

Inventors:
Elihu Thomson.
E. W. Rice.
By their Attorney: H. L. Townsend.

# UNITED STATES PATENT OFFICE.

ELIHU THOMSON AND EDWIN WILBUR RICE, OF LYNN, MASSACHUSETTS, ASSIGNORS TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

## ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 440,662, dated November 18, 1890.

Application filed January 3, 1884. Serial No. 116,300. (No model.)

*To all whom it may concern:*

Be it known that we, ELIHU THOMSON and EDWIN WILBUR RICE, citizens of the United States, and residents of Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

Our invention relates to electric-arc lamps; and its object is primarily to furnish a simple and efficient lamp in which the feed-regulating operations shall be under the control of a current flowing in derived circuit only and acting in opposition to a suitable retractor in contradistinction to those forms of lamp in which the regulation is dependent upon the differential action of currents in main and derived circuit coils or helices.

Our invention relates to certain improvements in the construction of an electric lamp of the kind in which an assisting or auxiliary coil is combined with the derived-circuit regulating-coil, the office of which auxiliary coil in the electrical combination is to bring the feed-regulating mechanism into normal or operative position, and then, being automatically cut out or rendered electrically inoperative, to leave the feed-regulating mechanism to the control of the varying current in the ordinary derived circuit of high resistance around the carbons. When the lamp ceases to be operative or the circuit is turned off, the feed-regulating devices resume their extreme retracted position, and the auxiliary coil or magnet is then again introduced into circuit, either automatically or by hand, ready for the next operation. The auxiliary or starting coil may be of any construction or introduced into the circuit in any way, provided it be properly arranged to act upon the regulating mechanism or to assist the high-resistance derived-circuit magnet in acting upon the same, so as to bring the latter into operative position. It may be cut out or rendered electrically inoperative by any desired arrangement of circuits or switches properly constructed to eliminate the effects of such coil from the combination when the lamp mechanism has been started and to hold it eliminated so long as the lamp continues to act. When the lamp ceases to act or the current is cut off, said coil is again introduced into the circuit, so that its assisting or starting function may again be made use of at the next operation. The circuit-controller whereby this may be effected may be of any desired kind, but should be so arranged as to act automatically to throw out the coil when the lamp mechanism has been brought to the proper point. This point ordinarily will be that at which a release of the carbon would be produced. The circuit-controller should retain a proper position to keep the coil cut out while the lamp continues to burn.

In the form of lamp which we have herein illustrated for the purpose of showing our invention the auxiliary or starting coil is in a branch around the carbons, and in such case the carbons are either apart at the start or the carbon-circuit is broken at some other point or rendered abnormally high in resistance, so that the starting-coil may be effective. In this plan, the carbons being apart, the circuit is meanwhile completed through the branch around the carbons containing an electromotor device or a device controlling a mechanical motor, and the regulating-lever is pulled down or the mechanism is otherwise acted upon, so that the carbons may come into contact, immediately after which the branch is opened, either directly or indirectly, and is kept so until it is again required for starting the lamp. The branch being thus opened, the regulating-lever is retracted, thus forming the arc, and the regulation then goes on in the ordinary way under the control of the current which flows in the derived circuit of high resistance and varies with the variations of length of arc.

Our invention consists in the special combinations of devices and improved features of construction that will be described in connection with the accompanying drawings, and specifically recited in the claims.

Our invention is applicable to clutch mechanisms for feeding carbons, whether directly or by the agency of the metal carbon rod or holder. It is also applicable to clock-work mechanism in a similar way.

In the accompanying drawings, Figure 1 is

an elevation of one form of lamp embodying our invention. Fig. 2 shows a portion of the circuit-controlling device in detail. Figs. 3, 4, 5, 6, and 7 show modified dispositions of the coils and magnets. Fig. 8 shows a modified plan of utilizing the starting coil or magnet to assist the high-resistance regulating-magnet. Fig. 9 shows another way of applying the assisting coil or magnet. Figs. 10, 11, 12, and 13 show ways of utilizing a magnet instead of a mechanical device for preserving the starting-circuit through a definite range of movement of the feed-regulating armature-lever. Figs. 14, 15, 16, and 17 show modifications of the circuit-controller. Fig. 18 illustrates the application of our invention to a clock-work or gear-train lamp. Fig. 19 shows an arrangement in which the heating effects of the current in the starting-circuit instead of the magnetizing effects are employed for starting the lamp.

In Fig. 1, A indicates a core of a magnet whose pole P is preferably paraboloidal or approximately paraboloidal in shape, as indicated, while its armature B B is provided with an opening over said core and having rounded edges. This form is the same as that described in a prior patent granted to E. Thomson, and is adopted in order to obtain uniformity of magnetic pull in all positions of the armature for the same strength of current in the coils of the magnet.

L indicates the regulating or feed-controlling armature-lever of the lamp, connected through an adjustable link or connecting-rod D with a suitable feed-controlling mechanism, shown in the present instance as a clutch of the same general form as that heretofore patented to E. Thomson, and consisting of a clamp-body C, a pivoted clamping toe or dog *d*, and a releasing-stop F.

R indicates the usual rod or carrier for the upper carbon, and E E′, respectively, the upper and lower carbon sticks. The magnet A is wound with two helices, shown one superposed on the other, though they may be contiguous on the core. These are indicated at G K. The coil K is the usual derived-circuit coil of high resistance around the arc. This derived circuit is indicated by the numeral 5. The coil G is at times in a branch circuit of low resistance, especially at the start, and afterward has its circuit opened by its own action, directly or indirectly. During burning of the lamp the coil G is ineffective or open-circuited, having been utilized only to effect an approach of the carbons into contact. There is, therefore, a saving of energy in operating our lamp, since there is no coil traversed by the direct or main current. The loss of energy due to this cause alone in ordinary lamps is often nearly five hundred foot-pounds per lamp per minute. It will be understood that the clutch C is required only to grip the carbon-rod when elevated and release it when depressed, and our invention includes the use of any well-known form of clutch in place of C or other equivalent mechanism.

The circuit-controller by which the circuit of coil G is controlled is here shown as a mechanical trip circuit closer and breaker, with which the lever L engages when in an extreme retracted position, so as to close the circuit of G. When the lever is drawn down by the action of coil G, it carries the circuit-closer with it to a predetermined point, such that the clutch is released and the carbons come into contact. At this point the circuit-closer is released, breaks the circuit of G, and recedes to such a point that the circuit will only be closed again when the lever L recedes to an extreme position. The circuit-closing points are in the present instance formed one Q′ upon the armature B and the other upon a catch Q, mounted on the end of an insulated spring $Q^2$, which normally will hold the catch Q raised to a position indicated by the dotted lines and out of ordinary range of the armature in regulating the feed. When the armature is retracted to its extreme position by its retractor S, the catch Q catches under the armature, and in so doing closes the contact Q′, thus completing the circuit for coil G from X through $Q^2$, Q, B, and 5. The form of the catch Q is such that, as shown in Fig. 2, when the armature B B is drawn down, bringing Q with it, the latter finally strikes a surface *b*, which throws Q out of engagement with B, thus breaking contact at B Q and permitting spring $Q^2$ to raise the contact Q to its extreme upper position. Insulation (shown at *a*) is interposed to prevent restoration of contact unless the catch is used to effect it. The lever L is given a limited range between stops, and the clutch C′ is set to release the carbon-rod R when L is down and to grip and raise it when up. The carbons are in the usual direct circuit from X to Y, as indicated. In the figure the coil G is shown in the act of drawing down the lever L.

The operation of the lamp is as follows: Before passage of current the catch Q is at the start in engagement under B B, and the spring S holds the armature B B at its highest point. The carbons E E′ are either separated or they are in light contact. When current is turned on, it passes through the coil G and strongly magnetizes the core, thus drawing down the armature-lever L against the force of its retractor S and at the same time lowering the clutch. This movement continues until the clutch is released and the carbons permitted to come together, at or after which time the circuit-controller is released by impinging against *b*, thus opening the circuit of G, so that the core A is now not sufficiently magnetic to hold the lever against the retractor, and the latter, asserting itself, lifts the clutch and forms an arc. When the balance between the action of current in coil K and spring S is established, the lifting movement ceases, leaving an arc of the determinate regulated length. If the arc increases in

length, the coil K increases in power and lowers the clutch, so as to release the carbon and permit a feed of the same to take place. These actions are repeated indefinitely while G remains open-circuited, because on the release of the circuit-controller the spring $Q^2$ is raised and is now holding the contact on the catch at such a height that the circuit of G cannot be closed during ordinary movements of L in producing a feed. A stoppage of current in the circuit releases the armature from the attraction of the magnet K, and the catch Q is locked by the elevation of B B to again repeat its action on the re-establishment of the current. It is advisable that the magnet A G K have a considerable range of action upon its armature, and it is best if such action be uniform in various positions. The power of the spring S is nearly uniform as a retractor. Of course a weight may be used instead of the spring S or other equivalent retractile force employed. It is unessential that the coil G be wound on the same core as K, provided it can perform the functions already ascribed. In Fig. 3 the coil G constitutes the winding of a separate magnet from K, and whose armature B′ is hung upon the lever L to perform the same actions as before described. In the construction of the lamp, Fig. 1, there will preferably be two cores A side by side and two magnet-coils G K, forming a modified horseshoe-magnet. Indeed, this construction is in Fig. 1 supposed present, the other coil and core being situated directly in the rear of the one shown. The manner of so duplicating and connecting is a procedure so well known in the art as to need no special description. The armature in such case is like that in Fig. 4, B B. Fig. 4 also shows that the winding G may occupy one core and K the other, instead of both being wound on the same core. Again, as shown in Fig. 5, axial magnets may be used, in which case the core $B^2$ is arranged to be attracted into the compound coil G K, and is connected, like armature B, to the regulating mechanism. It is evident that in our invention there is no differential action of the coils, as it matters little whether the current passes oppositely or in the same direction in each. Besides, during operation the coil K is the only one traversed by current.

In Fig. 6 the equivalent of Fig. 4 with axial magnets is shown.

In Fig. 7 the horseshoe derived-circuit magnet K K has its armature wound with a coil G, serving the purpose of magnetizing the armature B B for the same purpose as in former cases—viz., bringing the armature-lever into proper operative position at the start.

In Fig. 8 the separate magnet G, instead of directly acting upon L, may act to slacken the spring S through the accessory lever L′ and the armature B′. The magnet G, when thrown out of action, as before, will release the armature B′ and lever L′, restoring the power of the spring S by the agency of the spring S′.

In Fig. 9 the magnet G acts upon a lever L′ to depress the clutch C at the start, after which when the carbons come together it is thrown out, as before, at Q, and the spring S thereupon acts on L′ through spring S′ and lifts the clamp, so as to form an arc. Henceforth the armature B of the derived-circuit magnet K is alone the means of moving the clutch C through its connection thereto by the spring S′, lever L′, and rod D.

In carrying out our invention we are not limited to the employment of circuit-controllers mechanical in their action, but may employ devices such as shown in Figs. 10, 11, 12, and 13, which illustrate circuit-controllers in which a magnet (permanent or electro) is employed for maintaining the closure of contact by the circuit-controller during downward movement of the regulating-armature from an extreme retracted to normal or feed-regulating position, or to a position at which contact of the carbons shall have been brought about.

In Fig. 10 the device is shown as consisting of a magnet M, (permanent,) which sticks to B and effects a closure of the circuit until released by the stop *b* upon the descent of the armature B. The magnet M is mounted upon a spring, or at least held up by a spring Q′, which only permits the magnet M to approach B when the latter has been raised to an extreme position by the spring S. The operation is in all respects similar to that in Fig. 1; but the action is superior.

In Fig. 11 the magnet M is replaced by an electro-magnet J, arranged to be shunted through a short connection 7 by closing a contact *b*′ when it is pulled down to a certain point by B, when the latter is acted on by the current in coil G at the start. The magnet J, by sticking to the insulated armature B when the latter is moved under the influence of the coil G and by being shunted at *b*′ when drawn down to a certain point below that of opening of the clutch, acts in every way similarly to the mechanical catch Q in Fig. 1. The connections are also quite similar, the coils of magnet J being simply interposed from Q′ to B. Although for simplicity we have shown contacts formed through armature B or B′ and magnets M J arranged to stick thereto, this is by no means essential.

In Fig. 12 the magnet M is shown provided with a separate armature B′, insulated from B B, thus relieving B B of the necessity of being insulated. The effects are similar.

In Fig. 13 the location of magnet J of Fig. 11 is modified. In this case it is fixed in position upon an arm, while the lever L bears an insulated spring Q′, to which armature $R^4$ is attached. In this case the contact is formed by the sticking of $R^4$ to J, and the

necessary elasticity is provided by the spring Q′, as shown. The breaking of the contact is effected by a hook or stud $W^4$, that moves with lever L. The action is the same as before.

In Fig. 14 both magnetic and mechanical actions are combined. The spring Q′ bears its catch Q, which has also an attached armature $W^5$. The action of the catch in establishing connection when the lever is retracted is the same as in Fig. 1; but its release is effected by the armature $W^5$ coming opposite the permanent or electro magnet J′, thereby relieving the catch.

In Fig. 15 the catch is borne on the lever L, while the release is effected by reason of the fact that the engaging parts describe different arcs, Q′ and L being so centered or pivoted that in descending the catch Q moves outward while Q′ moves inward.

In Figs. 16 and 17 the catch Q is modified in form and mounting; but the action will be evident from the drawings at a glance.

No claim of joint inventorship is made to the special devices shown in Figs. 10, 11, 12, and 13, excepting in so far as they contain the principle of the invention forming the subject of this application.

In Fig. 18 the application of our invention to a clock-train lamp is illustrated. The lever F′ is the tilting lever or bar supporting the wheel-work, and $H^2$ is the detent, which permits the release of the train and a feed of the carbon when the right-hand end of the lever is depressed by the action of the coil K or G to a sufficient extent to release the gear-train escapement from the detent $H^2$. The circuit-controller is substantially the same as in Fig. 15, and is properly arranged to break the circuit of G when a complete release and contact of the upper carbon with the lower has been effected. The coil G is here shown as a double coil or solenoid, one portion of which moves within the other and virtually forms a core for the stationary portion of the coil. The principle and method of action are substantially the same as in Fig. 1. The coils G might be so wound that the stationary coil would exert a repelling action upon the interior portion and tend to thrust the latter portion outward. In this case the coil would be upon the opposite side of the fulcrum of F′ from K.

In Fig. 19 the heating effect of a coil G is utilized when traversed by a current to expand a fluid or gas contained in a surrounding case and depress a piston or metallic diaphragm $B^2$, acting on L, as shown, until the magnet M is pulled off its armature Q, and so opens the circuit, putting G out of action. The only difference in this case is that we substitute the heating effects of the current flowing in the starting-circuit to bring the lamp into action; but the general principle of operation is the same as in the cases already described, in that a starting-circuit is employed and is automatically switched out and remains out of action while the lamp operates.

Other modifications will readily be suggested to those skilled in the art.

What we claim as our invention is—

1. The combination, in an electric lamp, of a high-resistance derived-circuit magnet, a feed-controlling mechanism engaging with the carbon-carrier to suspend or normally hold the same in proper relation to the opposite carbon, a support for said feed-controlling mechanism actuated by the derived-circuit magnet in one direction to produce a feed and in the opposite direction by a suitable retractor, a starting-circuit, a circuit-controller with which a part moving with the feed-controlling lever engages when said lever is in an extreme retracted position, and a spring whereby said circuit-controller may be thrown into position out of range of the movements of the lever when the lamp mechanism has been brought to operative position, as and for the purpose described.

2. The combination, in an electric lamp, of a feed-controlling derived-circuit of high resistance, a starting coil or circuit, a spring-actuated circuit-controller for the latter, and a catch or hook moving with the support for the lamp mechanism for engaging with said circuit-controller when the armature of the derived-circuit magnet is in its extreme retracted position, as and for the purpose described.

3. The combination, in an electric lamp, of a feed-controlling derived-circuit magnet of high resistance, a support for the carbon and its feed-controlling mechanism actuated by said derived-circuit magnet operating in opposition to a suitable retractor, a starting coil or circuit, a circuit-controller for the latter, and an engaging device for engaging with said circuit-controller when the armature-lever of the derived-circuit magnet is in an extreme retracted position, so that on the movement of said lever in a direction to move the carbons together the circuit-controller may follow it, as and for the purpose described.

4. The combination, in an electric lamp, of a derived-circuit magnet, an auxiliary coil, and a circuit-closer, a catch for engaging or holding said circuit-closer in circuit-closing position when the derived-circuit armature is abnormally retracted, and a stop for disengaging said circuit-closer when the armature has been attracted to a predetermined point.

5. The combination, in an electric lamp, of a high-resistance derived-circuit magnet, a feed-regulating mechanism supporting the carbon-carrier and in turn supported by the armature-lever for said magnet, an auxiliary or assisting coil placed on the same core with the derived-circuit coil for drawing the armature-lever in a direction to cause the carbons to come together, and a circuit-breaker actuated by said armature-lever for automatically cutting off the flow of current in said auxiliary coil, as and for the purpose described.

6. The combination, in an electric lamp, of a high-resistance derived-circuit coil or magnet, a feed-controlling mechanism engaging with the carbon-carrier to suspend the same in proper relation to the opposite carbon, a support for said feed-controlling mechanism actuated by the derived-circuit magnet in one direction to produce a feed and in the opposite direction by a suitable retractor, an auxiliary or assisting coil wound upon the same core with said high-resistance coil and placed in an auxiliary circuit around the carbons closed at starting the lamp, and a circuit-controller governing said circuit and actuated by the said magnet, as and for the purpose described.

7. The combination, in an electric lamp, with the regulating-lever, of a contact-closing catch moving therewith, a circuit-controller engaging therewith when the lever is in an extreme retracted position, and a starting coil or circuit controlled by said circuit-controller, as and for the purpose described.

8. The combination, in an electric lamp, of two coils or circuits, both acting in the same direction upon a suitable lever or movable support, a feed-controlling mechanism engaging with the carbon-carrier to suspend the same in proper relation to the opposite carbon and in turn carried by said lever or support, and a circuit-controller actuated by said lever for cutting off the flow of current to one of said coils at a predetermined point in the movement of the lever or support from its extreme retracted position.

9. The combination, in an electric-arc lamp, of a derived-circuit magnet of high resistance, a feed-controlling mechanism supported on the armature-lever of said magnet, a starting-coil, an armature therefor connected with the same lever, and means connected to said lever for cutting out or open-circuiting said coil when the lamp begins to act and hold it cut out, so that the feed-regulating action may go on under the control of the high-resistance derived-circuit magnet alone.

10. The combination, in an electric-arc lamp, of a derived-circuit magnet of high resistance in a branch around the carbons, an armature-lever therefor carrying the feed-controlling mechanism by which the carbon-carrier is suspended in proper relation to the opposite carbon, a starting or assisting coil in a second branch around the carbons, and a circuit-controller connected with the armature-lever of the derived-circuit magnet for throwing said starting-coil out of action, as and for the purpose described.

11. The combination, in an electric-arc lamp, of a derived-circuit magnet, a feed-controlling mechanism engaging with the carbon-carrier to suspend the same in proper relation to the opposite carbon, a support for said feed-controlling mechanism actuated by the derived-circuit magnet in one direction to produce a feed and in the opposite direction by a suitable retractor, a starting or assisting coil or circuit substantially such as described, and a circuit-controller for governing the action of said starting-coil, one of the electrodes of said controller being carried or operated by the support upon which the derived-circuit magnet acts, while the other is carried upon a separate movable support adapted to move independently of the first, as and for the purpose described.

12. The combination, in an electric-arc lamp, of a feed-regulating lever supporting the carbon, a low-resistance branch around the arc containing a magnet-coil acting on the same lever, and a contact-closing catch or its equivalent, as described, controlled by said lever, whereby the low-resistance branch is maintained until the feed-regulating lever is brought to normal position for producing a feed of the carbon.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 28th day of December, A. D. 1883.

ELIHU THOMSON.
E. WILBUR RICE.

Witnesses:
W. O. WAKEFIELD,
E. B. DOEN.