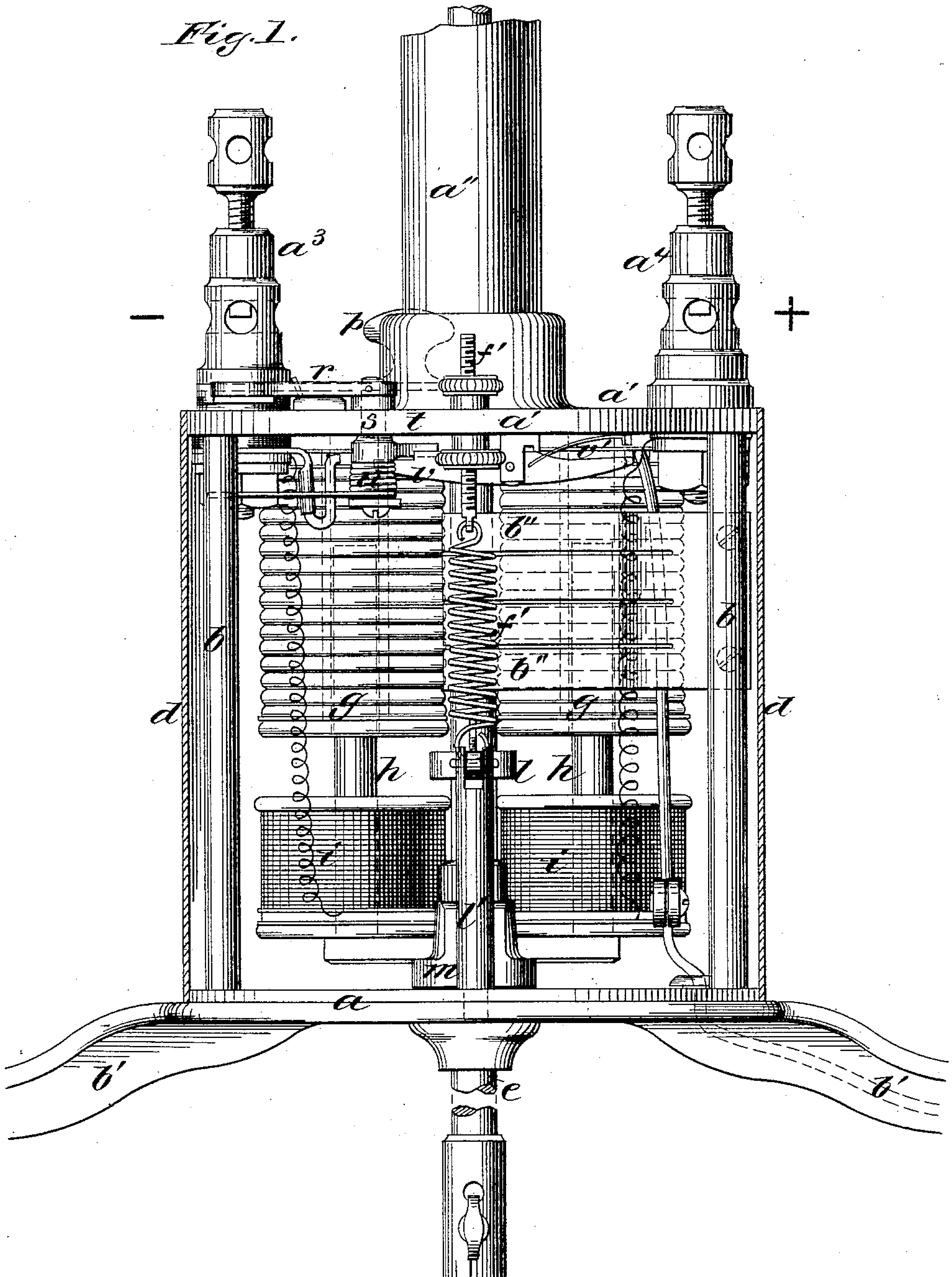
(No Model.) 3 Sheets—Sheet 1.

J. J. WOOD.

ELECTRIC ARC LAMP.

No. 337,289. Patented Mar. 2, 1886.

Fig. 1.



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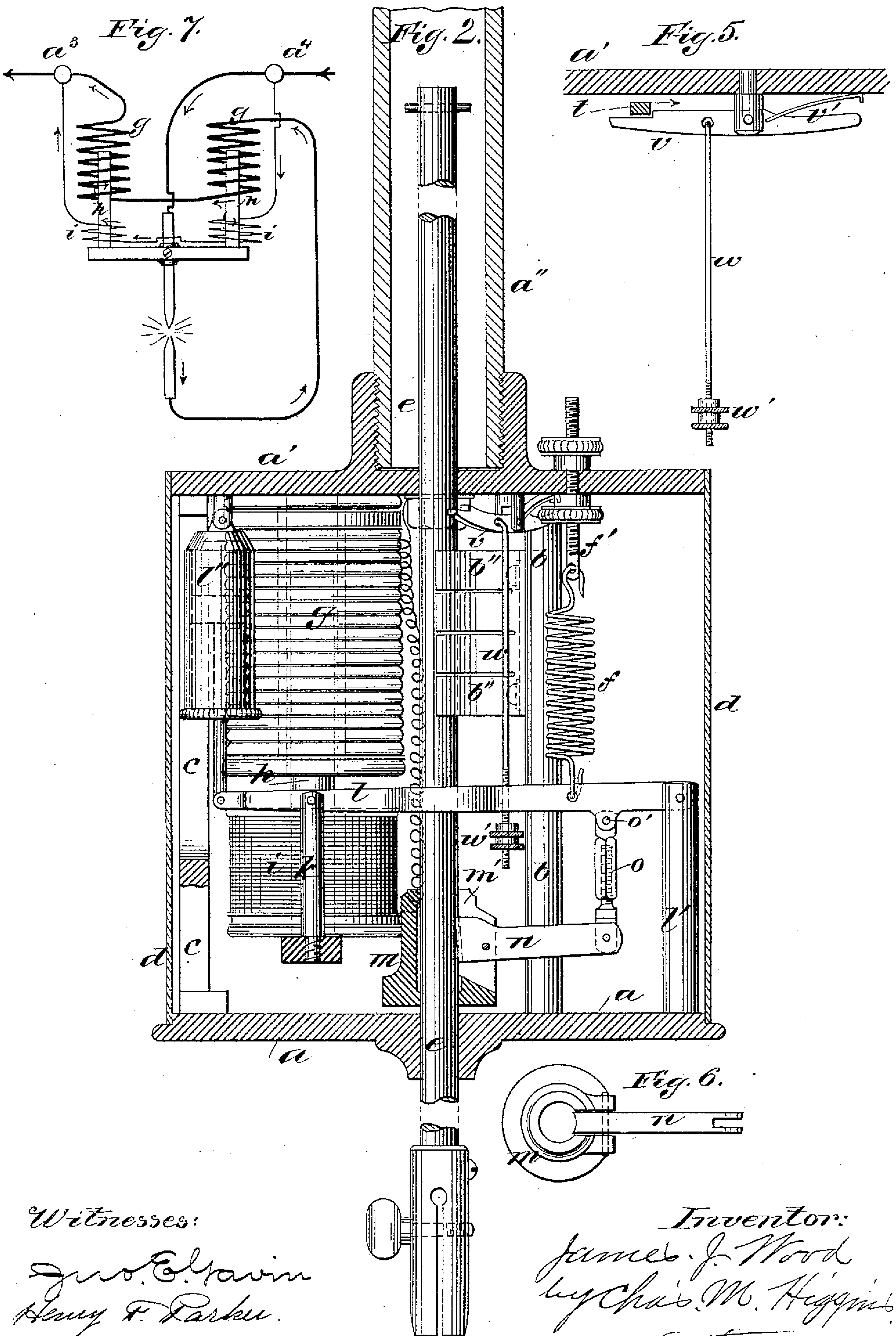

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Fig. 3

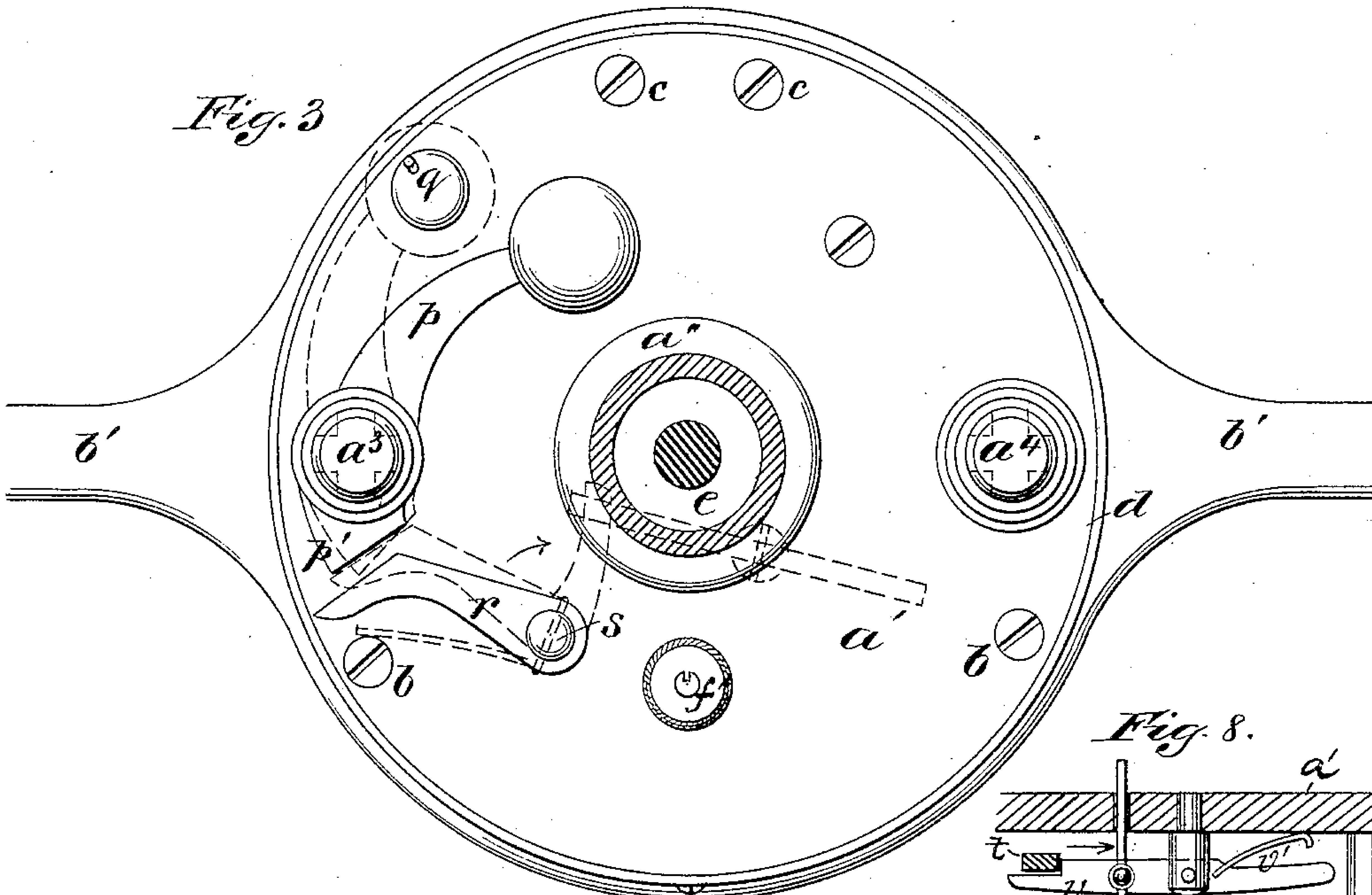


Fig. 8.

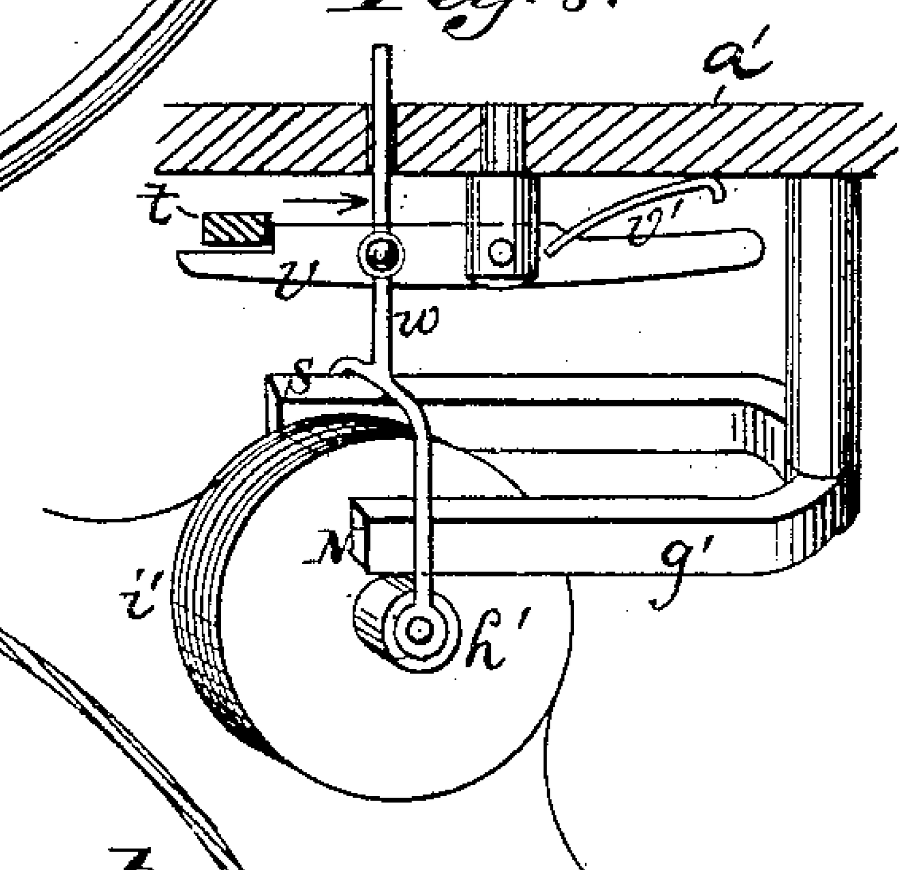
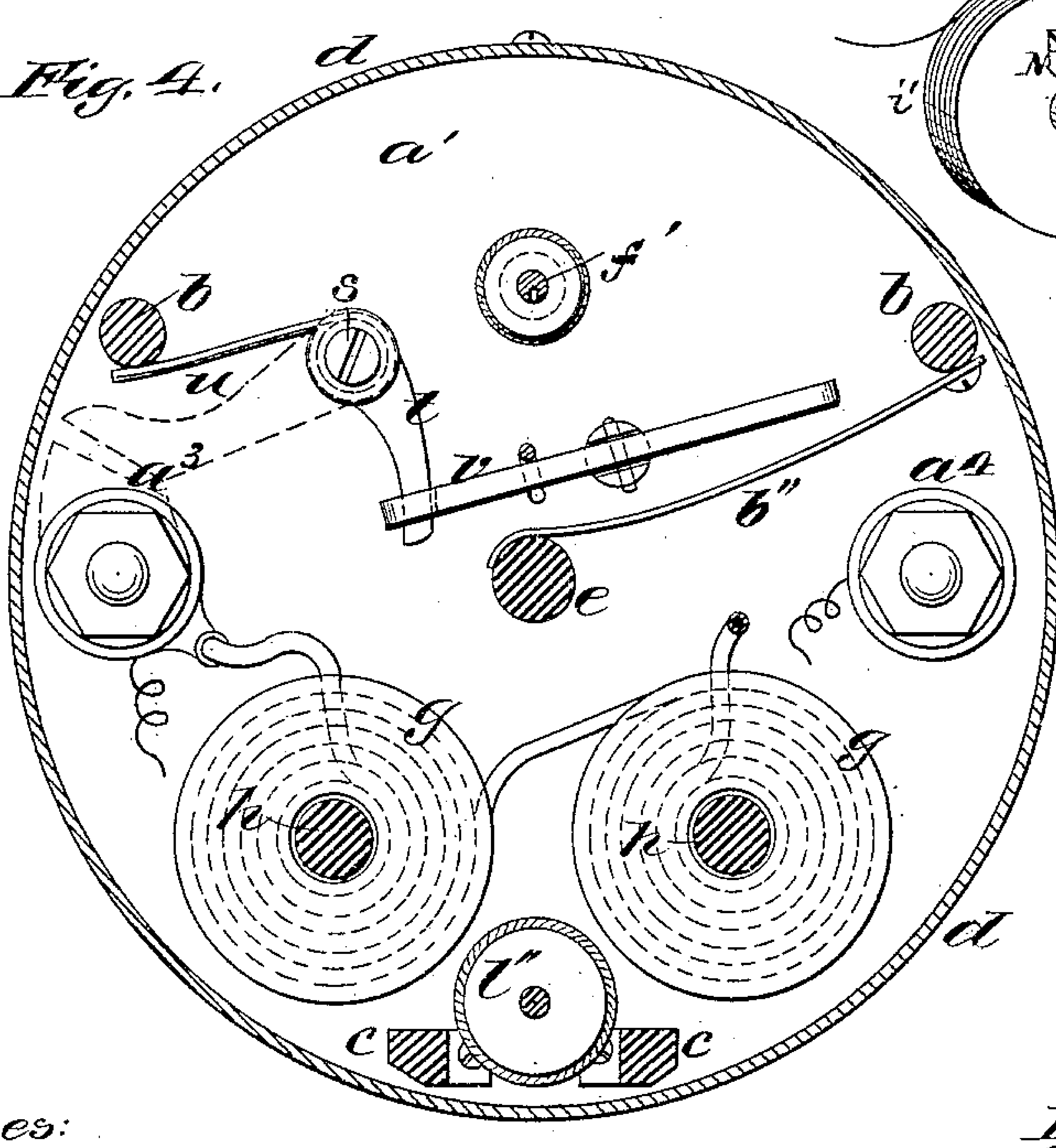


Fig. 4.



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UNITED STATES PATENT OFFICE.

JAMES J. WOOD, OF BROOKLYN, ASSIGNOR TO THE FULLER ELECTRICAL COMPANY, OF NEW YORK, N. Y.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 337,289, dated March 2, 1886.

Application filed April 4, 1883. Serial No. 90,625. (No model.)

To all whom it may concern:

Be it known that I, JAMES J. WOOD, of Brooklyn, Kings county, New York, (assignor to THE FULLER ELECTRICAL COMPANY, of New York city,) have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a specification.

The invention here specified relates to that class of lamps in which the regulating mechanism is provided with a clutch to grasp the carbon-holder, and which is actuated by differentially acting main and shunt magnets, the shunt-magnet being movable and acting as the armature to the main magnet, or vice versa.

Heretofore in lamps of this kind the movable shunt-armature magnet has been so pivoted or mounted as to swing or move laterally in front of the poles of the main magnet, which results in a comparatively indirect action of the attracting and neutralizing forces of the magnets upon each other, and a comparatively short range of motion, so that the magnets are unable to act with their full power. Now, according to my invention, I form one magnet, preferably the main, as a double solenoid, and the other magnet, preferably the shunt, as a horseshoe electro-magnet, the coils of the latter being wound on one end of its cores only, with the opposite naked ends projecting into the tubes of the solenoid and acting as the armature thereof. In this way I secure a greater range of motion and a direct action between the magnets in a straight line and in the path of greatest strength, the magnets acting successively with positive attractive neutralization and positive repulsion, which produces a powerful, simple, and sensitive action in controlling the carbons of the lamp to maintain a constant and steady arc.

My invention therefore consists, mainly, in the feature above outlined, and also in the special construction and arrangement of the said magnets, and further, in a special form of clutch and in an adjustable connection between it and the actuating mechanism, and in details connected with said mechanism, and with an automatic cut-out switch in the lamp, as hereinafter fully set forth.

In the drawings, Figure 1 is a front elevation of the mechanism of my improved lamp, the case inclosing the same being shown in section to expose the mechanism. Fig. 2 is a sectional side elevation of the same, and Fig. 3 is a plan view. Fig. 4 is an inverted plan of the upper head of the mechanism frame with attached parts of the mechanism. Fig. 5 is a detail of the cut-out mechanism. Fig. 6 is a plan view of the clutch; and Fig. 7, a diagram of the circuit of the lamp and the windings of the magnets. Fig. 8 shows a modification of the cut-out mechanism.

Referring to Figs. 1 and 2 the mechanism frame of the lamp consists, as usual, of the two circular heads *a a'*, which are joined rigidly together by two rods, *b b*, and by the standards *c*, which are screwed to the heads as usual. All the actuating mechanism of the lamp is included between said heads, and is inclosed and protected by the removable cylindrical case *d*, which is slipped over said heads according to the usual constructions. The upper or positive carbon-holder, *e*, slides centrally through the heads *a a'*, and onto the upper head is screwed the usual iron suspending-tube *a''*, which incloses the projecting portion of the carbon-holder. From the lower head project the arms *b'*, (see Figs. 1 and 3,) from which depends the usual harp, which supports the lower carbon, and the shade which surrounds the meeting points of the carbons, which parts are not shown, as they are presumed to be of the ordinary construction now well understood. From the upper head, *a'*, a pair of solenoids, *g*, depend, and into the tubes of these solenoids project the respective poles of a horseshoe electro-magnet, *h i*, which acts as the armature to the solenoids. The poles *h h* of this magnet-armature are wound on the ends near the neutral section only with bobbins *i i* of fine wire, as shown, the free ends of the poles being naked for a long distance to slide freely in the tubes of the solenoids, as illustrated.

Referring to Fig. 2, it will be seen that a rod, *k*, rises from the middle of the neutral section of the magnet-armature, between the bobbins *i*, and connects to one end of an armature-lever, *l*, which is pivoted at its opposite end to a post, *l'*, which rises from the lower head, *a*. This lever *l* extends diametrically across the case, being bowed or swelled at the center, forming an eye or opening to surround the carbon-holder and permit the same to work freely through it without interfering with each other, as will be understood from Figs. 2 and 1. The free extremity of the lever is connected with the piston of a pendulous air-cylinder, *l''*, which forms a check or dash-pot, which checks and prevents jerky or sudden motions of the armature. A clutching-hub, *m*, surrounds the carbon-holder near the face of the lower head, *a*, as seen in Figs. 2 and 1. This hub is bored with a hole, which is a nice working fit for the carbon-holder, but it is enlarged or counterbored at the middle, forming a recess surrounding the carbon-holder, as best shown in Fig. 2, so that the hub bears upon the carbon-holder only at each end of the bore. A vertical slit, *m'*, is cut in one side of the hub, extending into the bore, but not extending down through the entire length of the hub, as seen in Fig. 2, and in this slit is pivoted a dog or clamp-lever, *n*, with its short arm projecting against the carbon-holder, while its long arm projects outwardly. Now, the end of the short arm of the lever is formed with a concave cylindrical face, so as to accurately fit against the cylindrical side of the carbon-holder, as shown best in Figs. 2 and 6, and it is preferably made slightly curving, with a slightly-enlarging taper toward the lower end, so that the upper edge exactly fits the cylindrical curve of the carbon-holder, while the lower edge is out of contact therewith, as indicated by full and dotted lines in Figs. 2 and 3.

Referring to Fig. 2, it will be seen that the lever is pivoted at a point below its upper or grasping edge, and the construction is therefore such that when the lever lies horizontally or at right angles to the axis of the hub and of the carbon-holder it will exert no pressure on the carbon-holder, which can then move freely through the hub. If, however, the lever be swayed upwardly ever so little from this horizontal position, the keen obtuse chisel-edge at the upper angle of its grasping-arm will be forced against the carbon-holder, thereby causing the carbon-holder to be grasped between the hub and the dog at three equally-disposed points—that is, at two points at the top and bottom of the hub on one side of the holder and at one point near the middle of the recessed bore by the edge of the dog on the opposite side of the holder—which thus causes the holder to be held with an exceedingly firm well-disposed grasp, which acts instantly without danger of slippage, and without tending to cut or dent the holder or to become stuck or jammed.

It has been found that where the grasping-arm of the dog is formed with a curved cam-face to wedge itself against the carbon-holder, it does not catch so quickly or so firmly and is very likely to stick or jam, whereas when made like a chisel-pointed pawl, as described and shown, no such defects exist, and the action of the clutch is greatly improved. The long arm of the clutch-lever *n*, as seen in Fig. 2, is connected by an adjustable connecting-rod or turn-buckle, *o*, with the armature-lever *l*, near the pivoted end thereof, whereby the clutch and carbon-holder are thus operatively connected with the armature-magnet *h i*. Now, the weight of the armature-magnet *h i*, the armature-lever *l* and the clutch *m n* naturally tending to descend, causes the hub *m* to constantly tend to seat upon the lower head, *a*, and when once so seated the grasp of the clutch upon the carbon-holder will of course be immediately relaxed, for the strain of the weighted armature-lever *l* will then be applied in a reverse direction on the clutch-lever *n*, causing it to be swayed downward, and its grasp thus relaxed on the carbon-holder, which will then slide down freely through the hub, as will be readily understood. As soon, however, as the magnet-armature and its lever *l* are raised, the strain on the clutch-lever will be then applied in the upward direction, causing it to at once bite the carbon-holder and lift the hub and carbon-holder bodily with it, as shown in Fig. 2, which represents the clutch and carbon-holder raised, while Fig. 1 represents the parts in the reverse or down position with the clutch-hub seated on the head. In this lamp it will therefore be seen that the weight of the armature and its connected parts forms the retracting or feeding force of the lamp, and the attraction of the solenoid *g* on the armature-magnet *h i* forms the lifting or separating force, the two magnets having in addition a mutual reaction upon each other, as will be hereinafter described. A spring, *f*, however, which answers to the usual retracting-spring, connects at one end to the armature-lever, and at the other end to an adjusting-screw, *f'*, on the upper head, *a'*, and acts to support part of the weight of the armature and its connected parts, so that by adjusting this spring the weight will be neutralized more or less and the retractive force of the mechanism thus altered correspondingly, but in a reverse manner to ordinary retracting-springs—that is, by increasing the tension of the spring the weight will be more nearly balanced, and consequently the retractive force will be decreased, while by decreasing the tension of the spring the retractive force will be increased, as will be readily understood.

Now, by referring to Figs. 1 and 2, it may be observed that the solenoids *g* are wound with coarse wire, and are situated in the direct circuit with the carbons, while the bobbins of the magnet-armature *h i* are wound with fine wire, and are situated in a shunt around the carbons according to the usual differential system now adopted.

By referring to Fig. 7, which shows a diagram of the winding and the circuit of the lamp, the electrical flow and general action will be readily understood, in connection with Figs. 1 and 2. The circuit-wires connect, of course, to the binding-posts on the upper head, as seen in Fig. 1. The negative post a^3 is, as usual, insulated from the head, while the positive post a^4 is in metallic connection therewith. The current therefore enters at the positive post, flows through the frame of the lamp and the contact-springs b'' (see Figs. 2 and 1) to the upper carbon-holder, e, and flowing thence from the upper carbon through the arc to the lower carbon, (see Fig. 7,) passes thence to one end of the solenoid-coils g, and through said coils to the negative binding-post a^3. The two ends of the coils of the armature-bobbins i i connect directly with the respective posts, as shown in Figs. 7 and 1, so that the shunt-current flows directly through said coils from post to post independent of the carbons.

In Fig. 1 it will be seen that the connection between the bobbins i i and the binding-posts is formed by long flexible spirals, which permit a free up-and-down motion of the magnet-armature without breaking the connection.

Referring again to Fig. 7, it will be seen that the solenoid or main coils and the magnet-armature or shunt coils are wound in opposite directions, so that when a current is flowing through both sets of coils the armature will have the same polarity as the solenoid, and will hence tend to neutralize or repel each other according to the respective strengths of magnetism; but when little or no current flows through the shunt, as will normally be the case, the magnet-armature will be neutral, and the solenoid will then forcibly attract and lift it. It will therefore be understood that when the lamp is out of action the magnets will be powerless, and the weight of the magnet-armature and its connected clutch and carbon-holder will cause the same to descend, as seen in Fig. 1, causing the clutch-hub m to seat upon the head a, and thus relax its grasp on the carbon-holder, which will thence freely descend and allow the upper carbon to rest upon the lower carbon. When the lamp is now put in circuit, little or no current will flow through the shunt, while almost the entire current will flow through the carbons and the main magnet or solenoid g, which latter will then forcibly attract and lift the magnet-armature h i, and thus raise the clutch, and with it the carbon-holder, as seen in Fig. 2, separating the carbons and forming the arc. As the arc continues to increase by combustion, a proportional increase of current will flow through the shunt and cause it to magnetize the poles of the magnet-armature h i sufficient to weaken or neutralize the attracting force of the solenoid g, thus allowing the armature and its clutch to gradually descend, and thus release or feed the carbon-holder in the manner already described, so as to restore the arc to its normal condition, and these attractions and neutralizations of course take place in alternate order, and so frequently and gradually as to maintain a steady arc, as will be understood. It will be noted, however, that in case the armature-lever or carbon-holder or other parts should become stuck in their raised positions, and fail to descend under the conditions named, then the abnormal length of arc will cause an abnormally-increased current in the shunt, which will magnetize the armature h i with a stronger polarity than that possessed by the solenoid, and thus cause the armature to be repelled forcibly downward, so as to overcome the obstruction and insure the proper feed of the carbon. It will be therefore noted that the construction and action of the magnets in this lamp are particularly simple and effective, for as the magnets act upon each other in a straight line and in the field and line of greatest force the full effective power of the magnets is utilized, and a greater range of motion is obtained than is possible with the lateral or swinging arrangements of magnets heretofore used. It will be also noted that the leverage between the armature and clutch is such as to give the armature great power over the carbon-holder, the full stroke of the armature being about five-eighths of an inch, while the stroke of the clutch is about one-eighth, being thus about five to one, which enables the armature to act most positively and certainly on the carbon-holder, and to cause slight changes in the arc to be instantly felt and regulated, thus rendering the arc exceedingly steady. It will be therefore noted that in this lamp the "separating" movement—that is, the lift of the clutch and carbon-holder—is very small, being less than the eighth of an inch, for the lamp here illustrated is more especially designed to operate with very small arc, so that a large number of lamps may be operated in one circuit, and a wider and better distribution of the light thus obtained. I therefore term this lamp my "semi-incandescent" lamp, as the arc will seldom be of any appreciable length, the carbons being merely out of contact or the pressure relaxed at the points to produce the light, and I find that the long range of motion of the magnets and the power and mutual action thereof with the concentrated leverage on the carbon-holder, as before described, form important elements to insure sensitive and certain action in a lamp of this class. The same mechanism may, however, be used in lamps operating with long arcs with similar advantage, as will be understood. The effective stroke of the clutch and the point in the downstroke of the armature at which it will seat upon the head a and release the carbon-holder is regulated by altering the length of the turn-buckle or connecting-link o, which is readily done by removing the coupling-pin o', and screwing one section of the link back or forth on the other section to the desired extent, and again replacing the pin, thus making the adjustment simple and in such a way that it cannot afterward become accidentally altered.

It will be noted that while I prefer and have illustrated a double solenoid, g, with a double bobbined or horseshoe electro-magnet as its armature, yet but a single solenoid and a single bobbined magnet may be used instead, but not with nearly so much advantage, for the double solenoid and horseshoe armature give double the magnetic power for the same current and material. It will be also appreciated that while I prefer to have the main magnet or solenoid stationary and the shunt-magnet movable to act as the armature, yet this may be reversed, if desired; but I do not recommend it. The limit to the attracting or up motion of the armature is caused by the heads of the bobbins *i i* striking the heads of the solenoids *g*, while the down motion is limited by the neutral bar of the magnet *h i* striking the lower head, *a*, thus forming simple stops to the motion of the armature. The normal retracting and feeding motions of the armature, however, never bring it down against the head *a*, but within about one-third of its full stroke therefrom. These normal motions of the armature are produced by the neutralizing action of the magnets, or occasionally by repulsion, as before described, while movement beyond the normal limit is caused always by repulsion. Thus if some defect exists in the lamp, so that the carbons fail to feed properly at the normal limit, then the repelling movement of the armature beyond this point will instantly operate an automatic switch to cut the now defective lamp out of circuit without affecting the others in the same circuit; and the remaining feature of my improvement relates to details connected with this cut-out, which is of the same general character as that covered in my former patent, No. 261,289, dated July 18, 1882, and will be now described.

Referring to Figs. 1 and 3, *p* indicates a hand-switch, which is mounted so as to turn on the stem of the negative binding-post, and when it is swung out, so as to rest on the seat *q*, as indicated by dotted lines in Fig. 3, it will cut the lamp out of circuit, and when moved off the seat, as shown by full lines, it will put the lamp into circuit. The pivoted end of this hand-switch is formed with a contact-face, *p'*, against which the automatic switch arm or hammer *r* will rest when released. This hammer *r* is pinned to a rock-shaft or stud, *s*, which passes through the upper head, and on which is fixed a detent-arm, *t*, below the head. A strong torsional spring, *u*, wound on the stud *s* and arranged as seen in Figs. 1 and 4, tends to constantly turn the stud so as to close the switch-hammer, as indicated by dotted lines in Fig. 3. When the switch-hammer *r* is, however, set in its open or cocked position against the stress of the spring, as indicated by full lines in Fig. 3 and dotted lines in Fig. 4, the detent-arm *t* will engage with the notched end of a trigger-lever, *v*, (see Figs. 1, 4, and 5,) which lever is held in engagement with the detent by a spring, *v'*, thus holding the switch-hammer in its cocked position ready for instant release when required. Now, a rod or wire, *w*, extends downward from the engaging end of the trigger-lever *v* to the armature-lever *l*, and passing through a hole therein is threaded on its lower end and provided with adjustable jam-nuts *w'* below the lever. Now, these nuts are so set that during normal movements of the lever up or down the lever will not contact therewith, and hence will have no effect on the cut-out switch. If, however, the lamp fails to feed properly when the armature retracts to its normal limit, then the armature-lever will contact with the nuts *w'*, and any further retraction of the armature will depress the rod *w* and trigger-lever *v*, thus releasing the detent *t*, and allowing the switch-hammer *r* to fly shut, and thus automatically cutting the defective lamp out of circuit. By adjusting the nut *w'* up or down on the rod *w* the mechanism will be adjusted, so as to release the cut-out switch at a smaller or larger departure from normal conditions, as will be readily understood.

The novel arrangement of regulating-magnets shown may of course be used, with any suitable form of operative connection between the armature and the carbon-holder or movable electrode, besides the armature lever *l* and clutch *m n* herein shown. It may be also noted that in this lamp the regulating-magnet serves at the same time as the magnets to operate the cut-out; but, if desired, a separate pair of magnets of smaller size than the regulating-magnets, but of precisely the same kind, may be used to operate the cut-out independently of the regulating-magnets. In case that small separate magnets are thus employed to operate the cut-out, I would prefer to have them modified, as shown in Fig. 8. The main magnet *g'*, which will take the place of the solenoid *g* in the former case, is in this modification a fixed permanent magnet, while the armature *h' i'* is an electro-magnet, with its coil in a shunt around the arc, similar to the regulating-armature magnet *h i*; hence in this modification, when the arc gets abnormally long, the abnormally-increased current in the shunt will polarize the armature similarly to the permanent magnet, and thus repel the armature from the magnet, which armature will pull down the rod *w* and release the cut-out switch. In both the principal and the modification it will thus be seen that the cut-out action is produced by repulsion by the aid of a shunt-magnet acting oppositely to a primary attracting-magnet. In the first case the primary attracting-magnet is a solenoid in the arc-circuit, while in the modification it is a permanent magnet, the principle of action and result being therefore the same.

What I claim is—

1. In an electric lamp, a double solenoid, *g g*, in combination with a horseshoe electro-magnet, *h i*, wound at one end of their cores only, and the opposite ends naked and projecting into the tubes of the solenoid and acting as the core or armature to said solenoid, with the coils circuited and wound, substan-

tially as shown, and an operative connection between the armature and the carbon or carbon-holder, to regulate the position thereof, substantially as herein set forth.

2. The combination, in an electric-arc lamp, with a regulating magnet or motor, of the clutch-hub *m*, surrounding the carbon-holder or movable electrode of the lamp, with the lever *n* pivoted thereto and bearing at one arm on said electrode, with an operative connection between the opposite arm of said lever and the regulating-motor, and a seat, *a*, on which the hub is lowered, substantially as and for the purpose set forth.

3. In an electric lamp, the combination, with a cut-out switch and a trigger device to hold the same open, of a primary attracting-magnet and an electro-magnet circuited in a shunt around the arc, both magnets being operatively related with said cut-out switch, with one of said magnets acting as the armature to the other and operatively connected with the trigger, whereby an abnormal flow of current in the shunt-magnet due to abnormal arc will repel one of the magnets from the other, and thereby release the trigger and close the cut-out switch, substantially as herein set forth.

4. In an electric lamp, the combination, with a cut-out switch and a trigger device to hold the same open, of a permanent magnet and an electro-magnet circuited in a shunt around the arc, both magnets being operatively related with said cut-out switch, with one of said magnets acting as the armature to the other and operatively connected with the trigger, whereby an abnormal flow of current in the shunt-magnet due to abnormal arc will repel one of the magnets from the other, and thereby release the trigger and close the cut-out switch, substantially as herein set forth.

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