(No Model.) 4 Sheets—Sheet 1.

J. EINSTEIN.

ELECTRIC ARC LAMP.

No. 497,494. Patented May 16, 1893.

Fig. 1a.

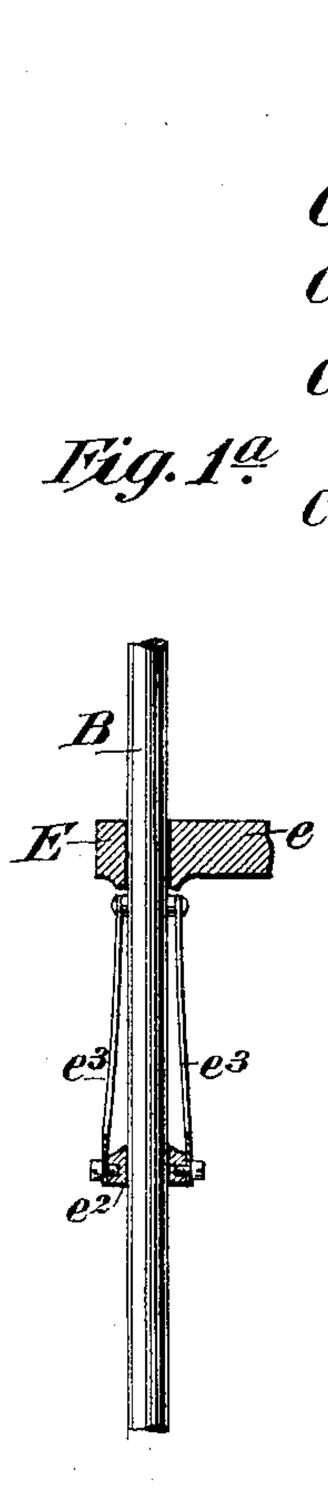
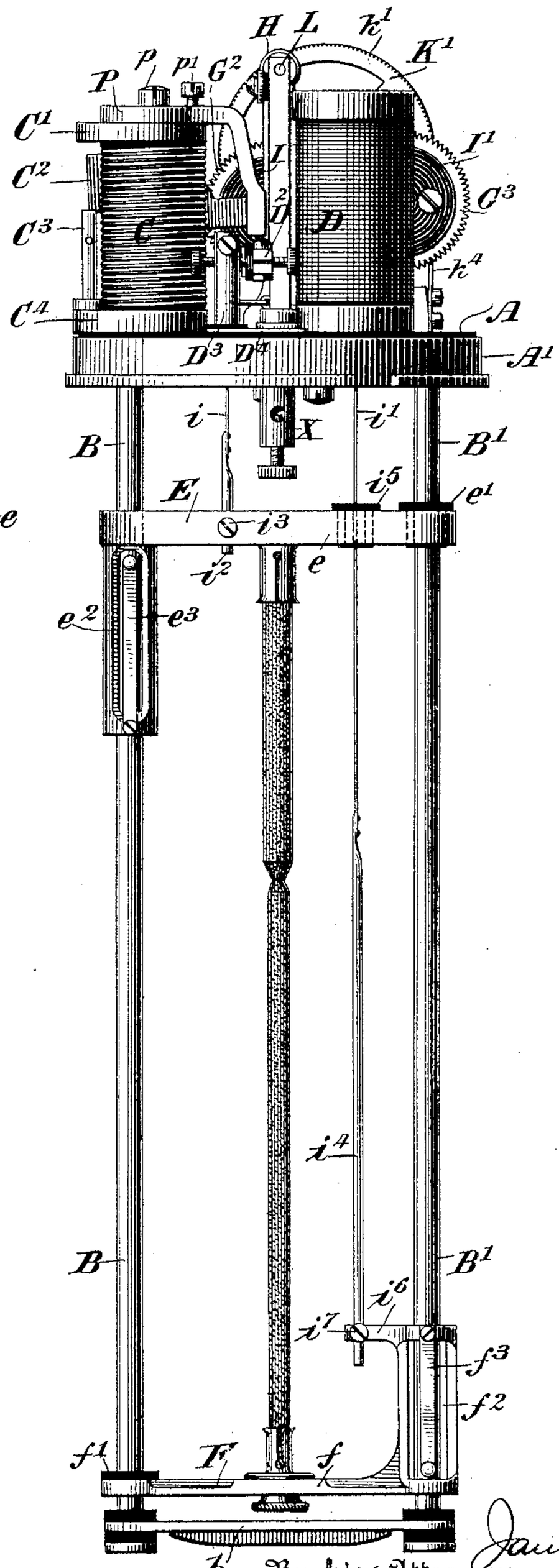


Fig. 1,



Witnesses

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(No Model.) 4 Sheets—Sheet 2.

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Fig. 2,

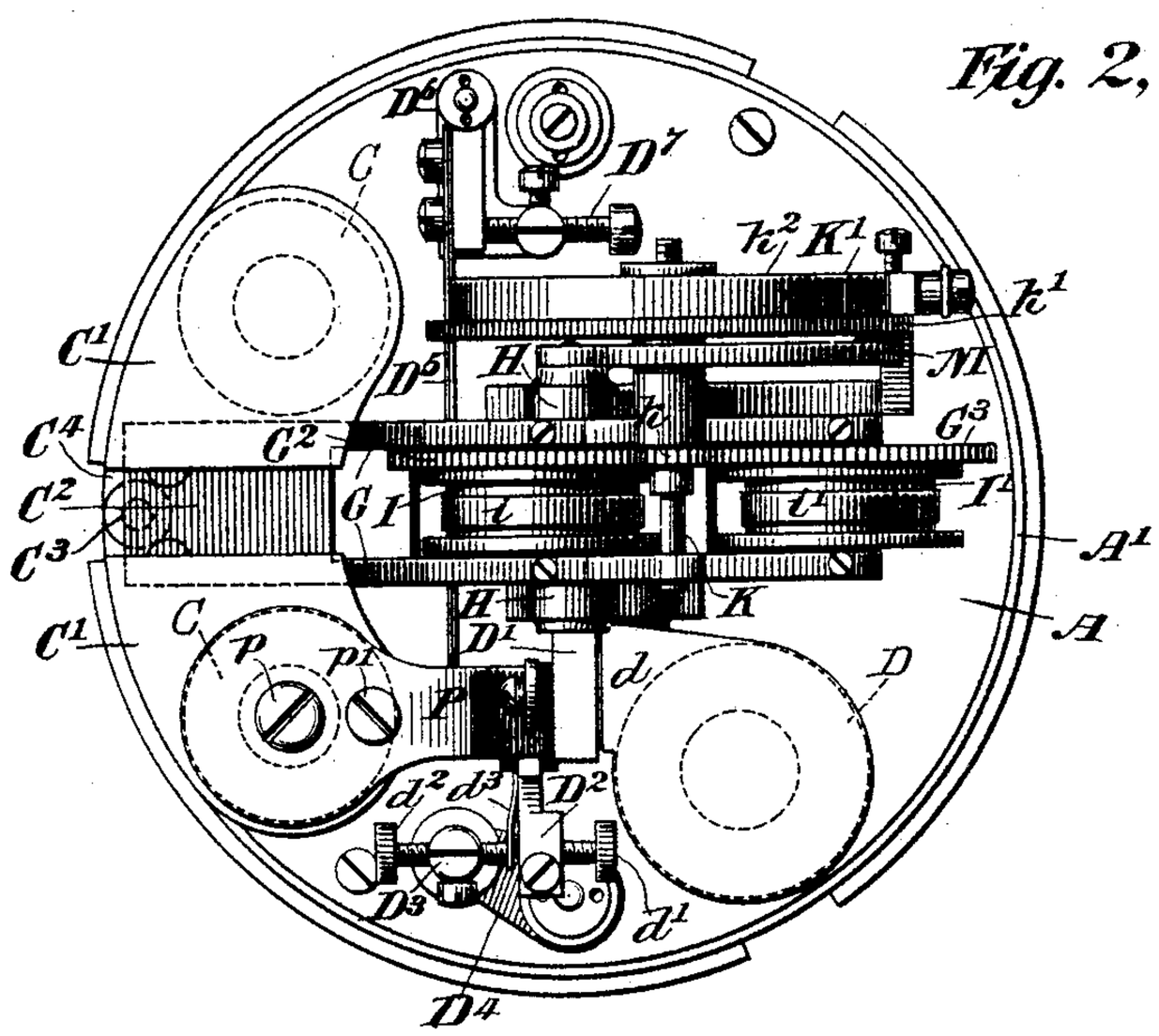
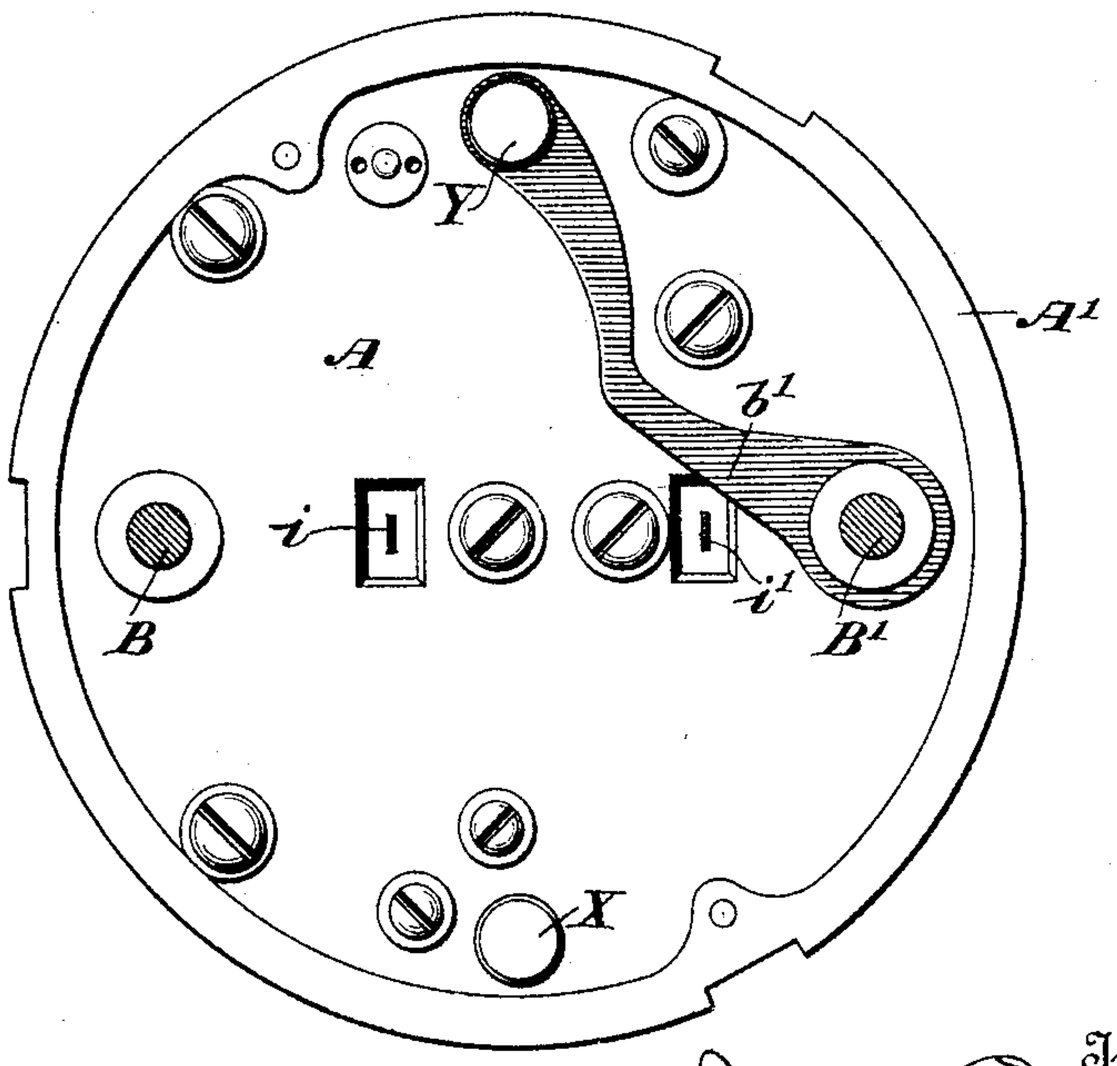


Fig. 3,



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4 Sheets—Sheet 3.

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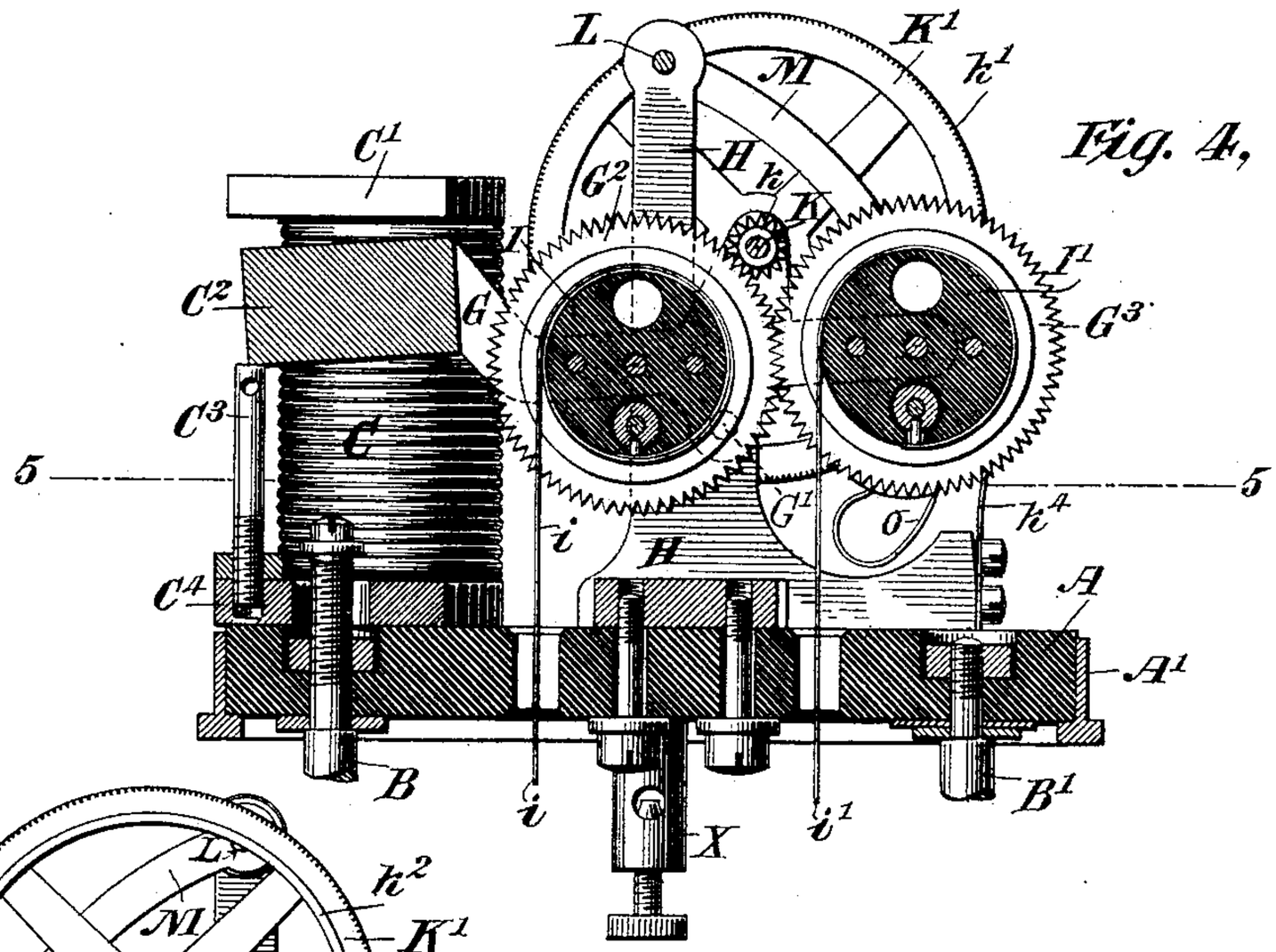

Fig. 4,

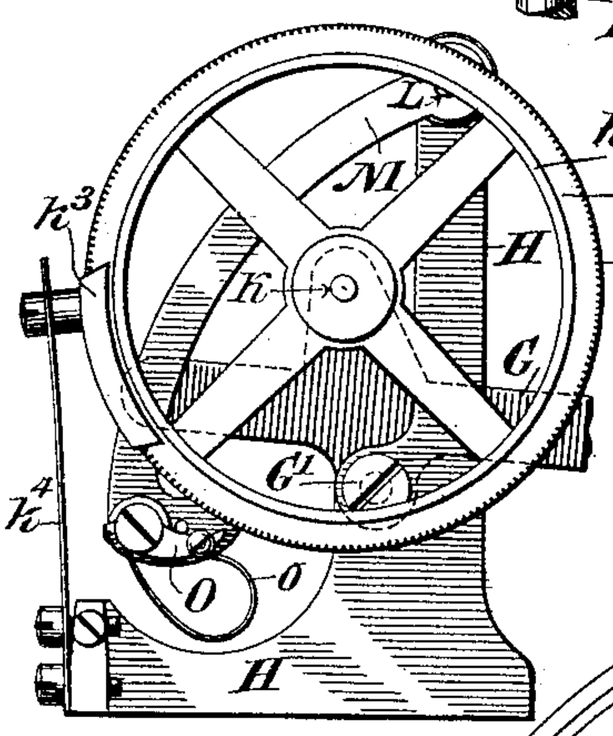

Fig. 6,

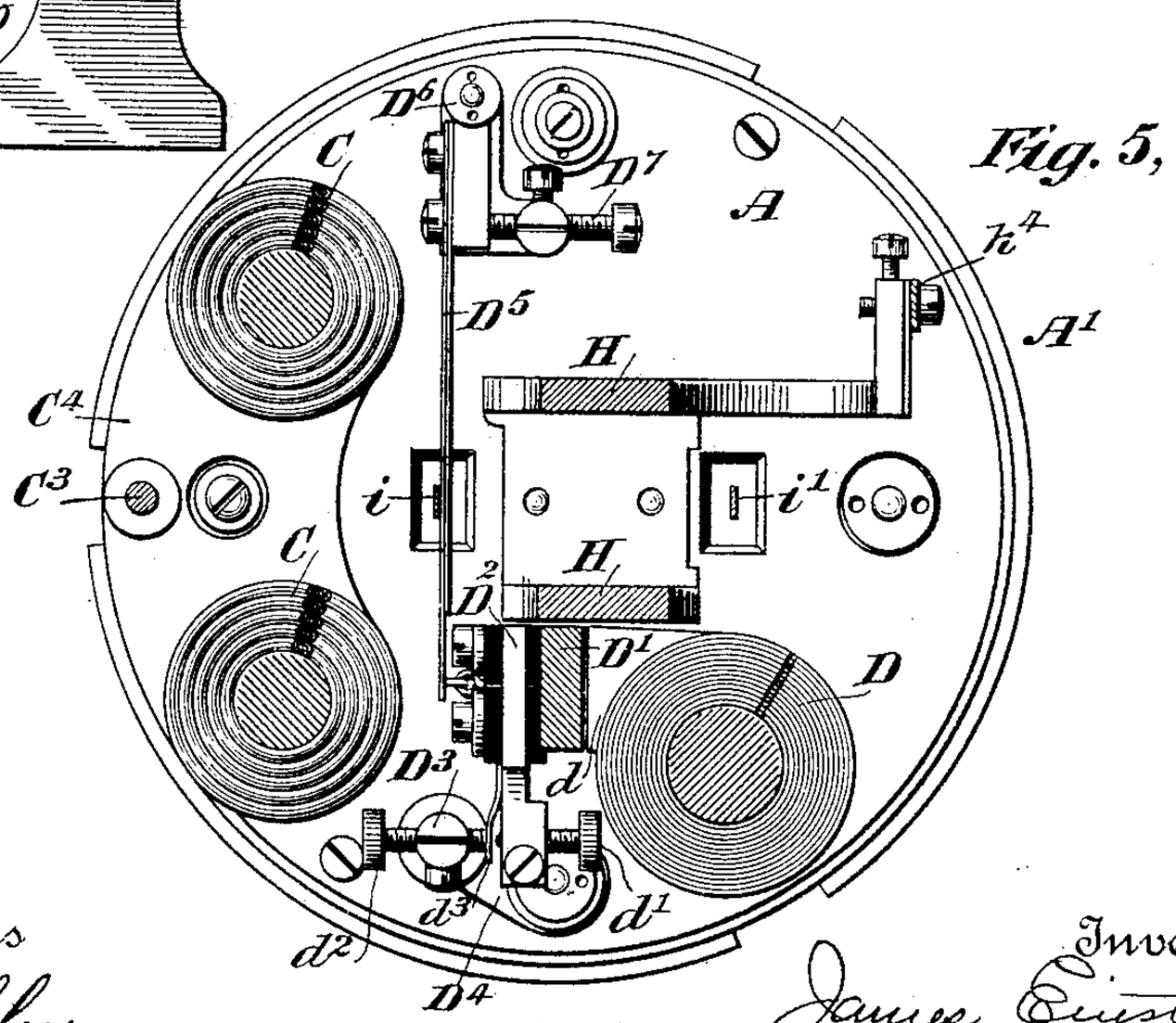

Fig. 5,

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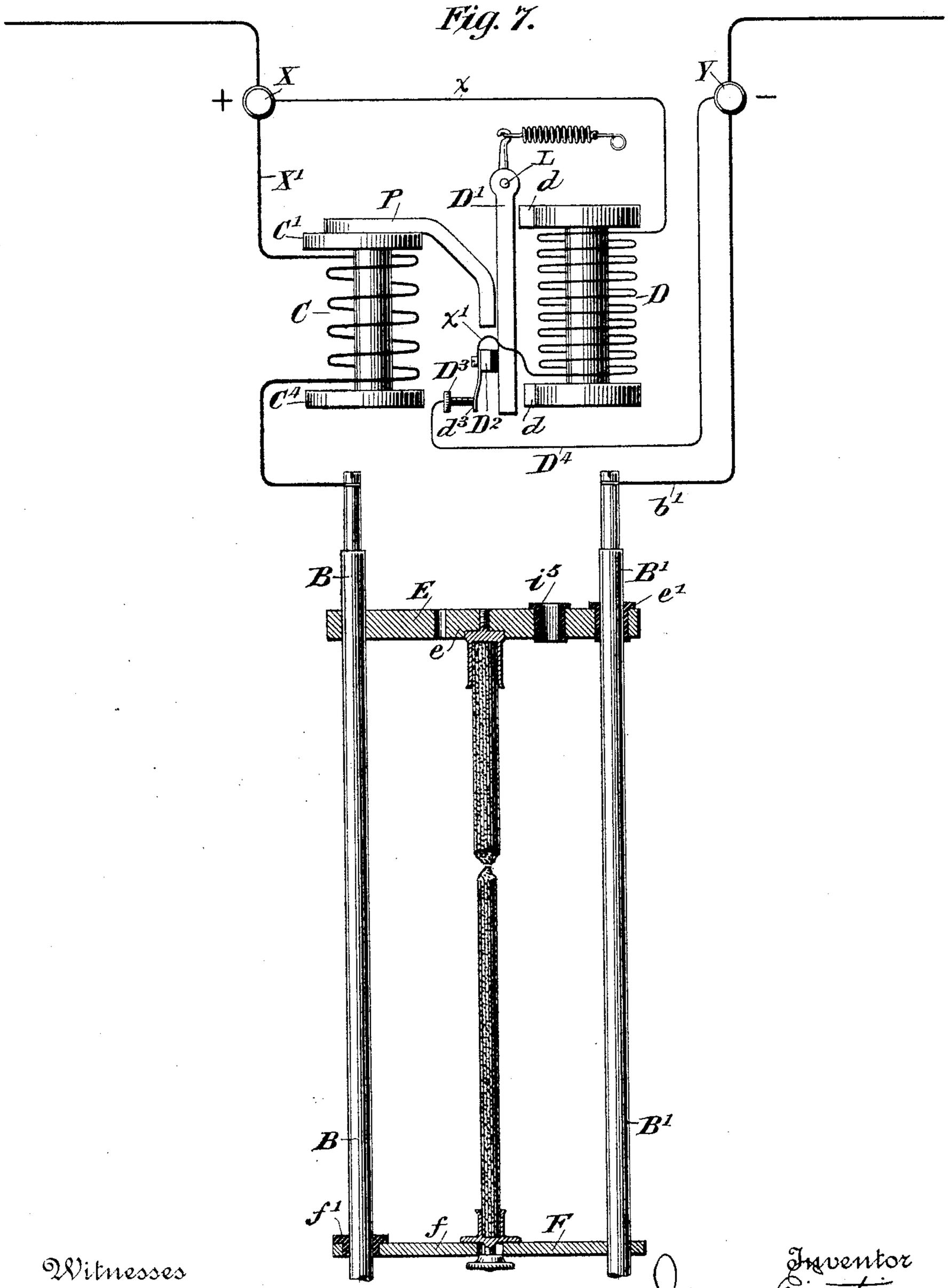
Fig. 7.



Witnesses
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UNITED STATES PATENT OFFICE.

JAMES EINSTEIN, OF MUNICH, GERMANY, ASSIGNOR TO PAUL LEMAIRE, OF NEW YORK, N. Y.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 497,494, dated May 16, 1893.

Application filed November 23, 1892. Serial No. 452,897. (No model.) Patented in Germany July 22, 1890, No. 53,207, and October 14, 1891, No. 59,347.

To all whom it may concern:

Be it known that I, JAMES EINSTEIN, a subject of the Emperor of Germany, residing at Munich, Bavaria, Empire of Germany, have invented certain new and useful Improvements in Electric-Arc Lamps, (for which I have obtained patents in Germany, No. 53,207, dated July 22, 1890, and No. 59,347, dated October 14, 1891,) of which the following is a specification.

The object of my invention is to produce an arc lamp that will feed on a very small variation in the length of the arc, in a smooth regular uniform manner, so as to maintain a substantially uniform arc.

To this end the invention consists in a new method of controlling the feed devices and in certain new organizations of apparatus.

A further object of the invention is to provide a compact, economical construction by which the bulk and unsightly appearance of ordinary arc lamps may be avoided.

My lamps may be made of various sizes and may be adapted to be run on arc or incandescent circuits.

The details of construction and general organization are hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a front elevation of the mechanism. Fig. 1ª is a detail view. Fig. 2 is a plan or top view. Fig. 3 is a bottom view of the disk or plate. Fig. 4 is a cross section of the upper part of the mechanism. Fig. 5 is a section, on the line 5—5, of Fig. 4. Fig. 6 is a detail view of the brake mechanism. Fig. 7 is a diagram of the circuits.

In the particular organization embodying my invention and shown in the drawings the frame work of the lamp consists of a plate or disk A of insulating material, such as slate or vulcanite reinforced by a circumferential band or ring A′ of metal, and carrying parallel pendent side rods B B′ connected at the ends by a metal cross-piece *b* insulated therefrom. The series magnet C and shunt magnet D are suitably mounted on the disk A substantially as shown or otherwise. The positive binding post X mounted in or on the disk is connected by a wire X′ through the coils of the series magnet to the side rod B from whence the circuit passes through the carriage E and the positive carbon carried thereby to the negative carbon and its carriage F to the rod B′ and the conductor *b* to the negative binding post Y. The shunt circuit runs from the positive binding post X by conductor *x* to one terminal of the coil of the shunt magnet, the opposite terminal thereof being connected by conductor *x′* with a contact arm D^2 carried by the shunt magnet armature D′ and from thence through the armature contacts to a post D^3 connected by conductor D^4 with the negative binding post Y. The pole pieces C′ of the series magnet may project toward each other and the armature C^2 be arranged below them and between the bobbins or coils of the magnet. This armature is carried by a frame G pivoted at G′ G′ in two standards H mounted on the disk A. When the current passing in the coils of the series magnet causes its armature to be attracted the frame is rocked upon its pivot, and the weight of the frame armature and parts carried thereby are so apportioned and related to the pivot that when the armature is released from the attraction of its magnet it falls by gravity and rocks the frame in the opposite direction. Of course a retractile spring may be used. This play of the armature may be regulated by a back stop consisting of an adjustable screw post C^3 mounted upon the yoke or cross piece C^4 of the magnet. The rocking frame carries on each side of its pivot a drum I I′ (preferably of insulating material) on which are wound straps, preferably metallic, *i i′*. The drum I is between the pivot of the frame and the armature C^2 and its strap *i* is connected with the positive carbon carriage E, and the drum I′ is on the opposite side of said pivot and its strap *i′* is connected with the carriage F of the negative carbon. Consequently, if the carbons are in contact, and a sufficient current is passed through them and the coils of the series magnet C, the armature C^2 will be attracted, and its frame rocking upon its pivot will raise the drum I and consequently the positive carbon, and will lower the drum I′ and permit the descent of the negative carbon carriage, thus establishing the arc be-

tween the carbons. Should one of the carriages stick on the rods and fail to move the arc could still be struck by the movement of the other carriage. The carbon carriages each run upon both side rods B B′ and are each counterbalanced so that although they are each supported at a single point by the strap *i* or *i′* they rise and fall in right lines without binding upon the rods. This may be accomplished in substantially the following manner: The carriages may consist of cross pieces *e*, *f*, on which the carbons are mounted in any suitable or usual manner. The side rods pass loosely through each end of the cross-pieces, the rod B′ being insulated from the cross piece *e* by a bushing *e′* of insulating material, and the rod B from the cross-piece *f* by an insulating bushing *f′*. The opposite ends of the cross-pieces carry extensions e^2, f^2, that may envelop the rods. The extensions may be of tubular form and have their sides cut away as shown to each permit one or more light spring contact arms e^3 f^3 mounted thereon to bear upon and rub against the side rods as the carriages rise and fall. The end of the strap *i* is connected to a short rod i^2 that passes through the cross-piece *e* between the side rods and is adjustably held therein by a set screw i^3. The weight of the carriage is so distributed with reference to this center of support that when the carriage is lifted by the strap the carriage does not cant or rock and there is therefore no tendency to bind against the side rods, and when the carriage descends in feeding the carbon as presently described it moves easily in a right line and without tendency to bind upon the rods. The strap *i′* carries upon its end a relatively long straight rod i^4 that passes loosely through an opening in the cross-piece *e* of the carriage E bushed with insulating material i^5 and through a laterally projecting lug i^6 on the tubular end of the carriage F and is adjustably held therein by a set screw i^7. The distribution of weight with reference to the center of support of this carriage is also symmetrical and there is no tendency for the carriage to bind upon the side rods.

The drums I I′ which as stated, are preferably of insulating material so that their special insulation from the frame is not necessary, carry toothed wheels or gears G^2, G^3 that mesh with each other. The rocking frame G also carries a shaft K having a pinion *k* fast thereon. This pinion may engage either of the gears on the drums, but preferably gears with the wheel G^2 on the drum that supports the carriage of the positive carbon. The shaft K also carries a wheel K′ having its periphery serrated or provided with ratchet teeth *k′* and also having a plain peripheral portion k^2 that serves as a brake when pressed against a yielding brake shoe k^3 (carried by a spring arm k^4 mounted on one of the standards H), when the carriage is rocked by the attraction of the armature of the series magnet. Of course instead of combining the brake k^2 and ratchet *k′* upon a single wheel here might be two wheels, or the brake shoe might be applied elsewhere.

The armature of the shunt magnet is secured to a shaft L rocking in bearings in the standards H H and carrying an arm M on the end of which is mounted a ratchet pawl O that engages the teeth of the ratchet *k′* and is controlled by a suitable spring *o* in a usual manner. When the armature of the series magnet is attracted the carriage G is rocked in a direction to bring the brake wheel or periphery against the brake shoe and the ratchet into a position to be engaged and actuated step by step as the armature of the shunt magnet is attracted and released—thus effecting the feeding of the carbons as hereinafter described. The shunt magnet is in this instance shown as consisting of a single core and bobbin secured in a vertical position on the disk A with its armature D hanging from the shaft K along side of it. Two laterally projecting pole pieces *d d*, one at each end of the magnet, both act upon the pendent armature. The armature carries an arm D^2, insulated therefrom, and with which one end of the shunt magnet coil is connected. An adjustable contact screw *d′* in the end of this arm is arranged opposite a similar screw d^2 in the post D^3 (connected with the negative binding post as before described) and between the opposing ends of these screws plays a spring contact finger d^3 carried by and in contact with the arm D^2. The screws are so adjusted and the yielding or spring contact d^3 is so related to them that when, by reason of the lengthening of the arc, sufficient current is caused to traverse the shunt magnet coil to attract the armature D′ the spring contact d^3 remains upon the contact screw d^2 after the armature commences to move and maintains for a time the completion of the shunt circuit until the pawl O has been brought into a position to certainly engage the next tooth in the ratchet wheel, at which time the contact d^3 leaves the screw contact d^2, the shunt circuit is opened, and the armature D′ is thrown back by its spring D^5 driving the ratchet wheel (which is held under sufficient tension by the brake) one step through the medium of the shaft K and pawl O, and the shunt circuit is re-established. The pinion *k* moving with the ratchet wheel and gearing with the wheel G^2 on the drum I drives that drum or permits it under the strain of the gravity of the positive carbon carriage, to move one step, thus lowering the positive carbon. As the gear G^3 on the drum I′ is driven by the gear G^2 on the drum I the negative carbon is at the same time raised. There is therefore a double or a simultaneous feed of both carbons. The number of teeth on the ratchet wheel, and in the pinion and gears G^2 G^3 are so related that the extent of feed at each movement of the parts, *i. e.* upon each attraction and retraction of the shunt magnet armature may be very minute

and the feed may therefore be relatively constant and maintain a substantially uniform arc. The adjustment of the screw contacts of the armature lever may, of course, be such that the pawl O will be caused to move the ratchet wheel a distance of two or more teeth each time, but I prefer a minute frequently recurring feed for the reason stated. The positive carbon carriage is as shown made heavier than the other carriage, for a purpose that will presently appear.

The spring D^5 of the shunt magnet armature is shown as a flat plate spring secured in a bracket D^6 on the disk A and adjusted by a screw D^7. Any other form of spring may of course be used.

In order to give to the apparatus a further steadiness or delicacy of the feed movement, and to compensate for the tardiness of action of the shunt magnet due to the rise of temperature of its coil caused by the heated gases rising from the arc, the action of the spring D^5 upon the shunt magnet armature is supplemented by magnetic action from the series magnet by means of an angular piece of soft iron P which is bolted to one of the pole pieces of the series magnet by a bolt *p* and extends downward in proximity to the shunt magnet armature. Its relation to said armature may be adjusted by loosening the screw *p* and manipulating a screw *p'* extending through the head of the soft iron piece and working against the face of the pole piece. The intensity of the field of this polar extension of the series magnet varies, of course, with the current passing in the coils of the series magnet and its attractive power upon the shunt magnet armature acts in opposition to the shunt magnet. When, therefore, the arc lengthens and the current in the series magnet coils falls the attractive power of the polar extension on the shunt magnet armature correspondingly decreases, and the armature responds with a correspondingly increased facility or readiness to the effect of the increasing or increased current in the coil of its magnet. This organization gives to the armature an increased delicacy or sensitiveness and insures the uniform feed of the carbons. The same effect may of course be produced in many other ways obvious to the skilled electrician, and the invention is not limited to the special details shown but contemplates broadly the idea of varying the sensitiveness of the shunt magnet armature in proportion to the variations of the length of the arc.

The operation of the lamp is as follows: The carbons being in place and no current passing in the coils of the series magnet the brake shoe is not in contact with the brake wheel on the shaft K, and the weight of the positive carbon carriage will, assuming the carbons to be separated, cause the positive carbon to descend, and at the same time the gear G^2 on the drum supporting said carriage drives the gear G^3 on the drum of the negative carbon carriage, and the superior weight of the former carriage will lift the latter. The carbons are therefore always maintained in contact when no current is passing through the lamp. When a current is passed through the carbons and series magnet coils the armature of said magnet is attracted and the carriage G turning upon its pivots raises the drum supporting the positive carbon, and lowers the drum supporting the negative carbon. The carbons are, therefore, separated the desired distance and the electric arc established. At the same time the brake is applied and the ratchet brought into position to be operated upon by the pawl O. When, on account of the consumption of the carbons the arc lengthens, the increased current that will then flow through the shunt circuit causes the attraction of the armature D' and the ratchet wheel is driven one or more teeth, as the case may be, and by means of the pinion *k* drives the drum I, thus lowering the positive carbon, and the gear on that drum in turn drives the drum I' thus raising the lower carbon. As the teeth in the ratchet wheel are relatively great in number, the pinion small and the gears relatively large compared with the pinion, the extent of motion of either carbon carriage, or indeed their combined motion, is so small as to be scarcely observable by the eye. Notwithstanding the relatively minute extent of movement of the carbons, the motion is certain and positive, and recurs with sufficient frequency. A substantially uniform arc length is therefore maintained and there is no observable flickering of the light. Should a carbon break the points will at once run together again as described and the circuit through the series magnet coils will be re-established. I use a negative carbon of smaller diameter than the positive carbon for the reason that the consumption of the former is greater.

Considering the invention broadly, aside from the particular organization of ratchet wheel and pawl, a pallet or driving escapement may be used instead of the structure shown.

Other details may be varied more or less by those skilled in the art without departing from the principle of my invention. For instance, the idea of prolonging the continuity of the shunt circuit after the shunt magnet armature commences to move, to insure the actuation of the feed devices, is not limited to the specific structure shown, though that structure is an efficient one.

So other parts of my invention may be modified or varied and no attempt is made herein to point out the parts that may be changed or to specify the character of changes that may be made. I may add, however, that the series and shunt magnets may be replaced by solenoids, which are their obvious equivalents in this art.

I claim as my invention—

1. The combination, substantially as set forth, of the lamp frame consisting of the

plate or disk, and side rods, two winding drums mounted on the plate and geared together, the heavy positive carbon carriage supported from one drum and the lighter negative carriage supported from the other drum, whereby when no current is passing through the lamp the superior weight of the positive carbon carriage causes it to descend and simultaneously elevates the negative carbon carriage effecting a double or simultaneous feed.

2. The combination, substantially as set forth of the carbon carriages, their supporting drums, the straps running upon said drums, the rods in which they terminate and means for adjustably connecting the rods with the carriages.

3. The combination, substantially as set forth of the carbon carriages, their supporting drums, a pivoted frame on which said drums are mounted, one on each side of its pivot, and the series magnet of the lamp acting to rock said frame, whereby upon the passage of a current in the series magnet the frame is rocked and one carbon carriage elevated and the other depressed to strike the arc between the carbons.

4. The combination, substantially as set forth, of the carbon carriages, their supporting drums, the rocking frame on which they are pivoted, the series magnet having pole pieces laterally projecting toward each other and the series magnet armature mounted on said frame and arranged between the coils of the magnet and below the pole pieces.

5. The combination, substantially as set forth, of the carbon carriages, feeding devices, the shunt magnet controlling and operating said devices, its armature, the contact piece or screw carried thereby, the opposing contact piece or screw, and the yielding contact arranged between the opposing ends of said contact pieces.

6. The combination, substantially as set forth, of the carbon carriages, their supporting and feeding devices, the shunt magnet controlling and operating said devices, its armature, the arm carried thereby, the adjustable contact screw mounted in said arm, a similar adjustable contact screw mounted on the frame of the lamp and the spring contact finger interposed between the opposed ends of said screws and carried by the arm on the armature.

7. The combination, substantially as set forth, of the carbon carriages and their supporting and feeding devices, the series magnet, the shunt magnet controlling and operating said feed devices, the armature of said magnet, the shunt magnet circuit closer carried by said armature and an electro magnetic device acting in opposition to the attraction of said magnet on its armature, and means whereby the power of said magnetic device is varied in proportion to the amount of current passing in the coils of the series magnet.

8. The combination, substantially as set forth, of the carbon carriages, their supporting and feeding devices, the shunt magnet, its armature, the shunt magnet circuit closer carried by said armature devices operated by said armature and controlling and actuating the feed devices, a series magnet and a pole piece carried thereby arranged in suitable juxtaposition to the shunt magnet armature and attractively acting thereupon in opposition to the attraction of its magnet.

9. The combination, substantially as set forth, of the carbon carriages, their supporting and feeding devices, the shunt magnet, its armature, the shunt magnet circuit closer carried by said armature devices operated by said armature and controlling and actuating the feed devices, a series magnet and an adjustable pole piece carried thereby arranged in suitable juxtaposition to the shunt magnet armature and attractively acting thereupon in opposition to the attraction of its magnet.

10. The combination, substantially as set forth, of the carbon carriages, their supporting drums, the rocking frame on which said drums are mounted, one on each side of the pivot thereof, a series magnet acting to rock said carriage to establish the arc, gear wheels carried by the drums and meshing with each other, a shaft carried by the rocking frame, a pinion thereon engaging the gear of one of the drums, a toothed or ratchet wheel also carried by said shaft, a brake surface or periphery also carried by said shaft, a yielding brake shoe against which said surface is pressed when the carriage is rocked by the attraction of the series magnet, a pawl or driving device into the line of action of which said toothed or ratchet wheel is brought when the frame is so rocked and a shunt magnet controlling and operating said driving device or pawl.

11. The combination, substantially as set forth, of the carbon carriages, their supporting and feeding devices, the shunt magnet consisting of a single core or spool having laterally projecting pole pieces at each end, a shunt magnet armature supported upon one end of a rock shaft and extending alongside of the magnet so as to be acted upon by both pole pieces, an arm on the opposite end of the rocking shaft, a driving device or pawl that drives and controls the feed devices and the retractile spring on the shunt magnet armature.

In testimony whereof I have hereunto subscribed my name.

JAMES EINSTEIN.

Witnesses:
SEBAST KORNPROBST,
CARL PAUKNER.