(No Model.)

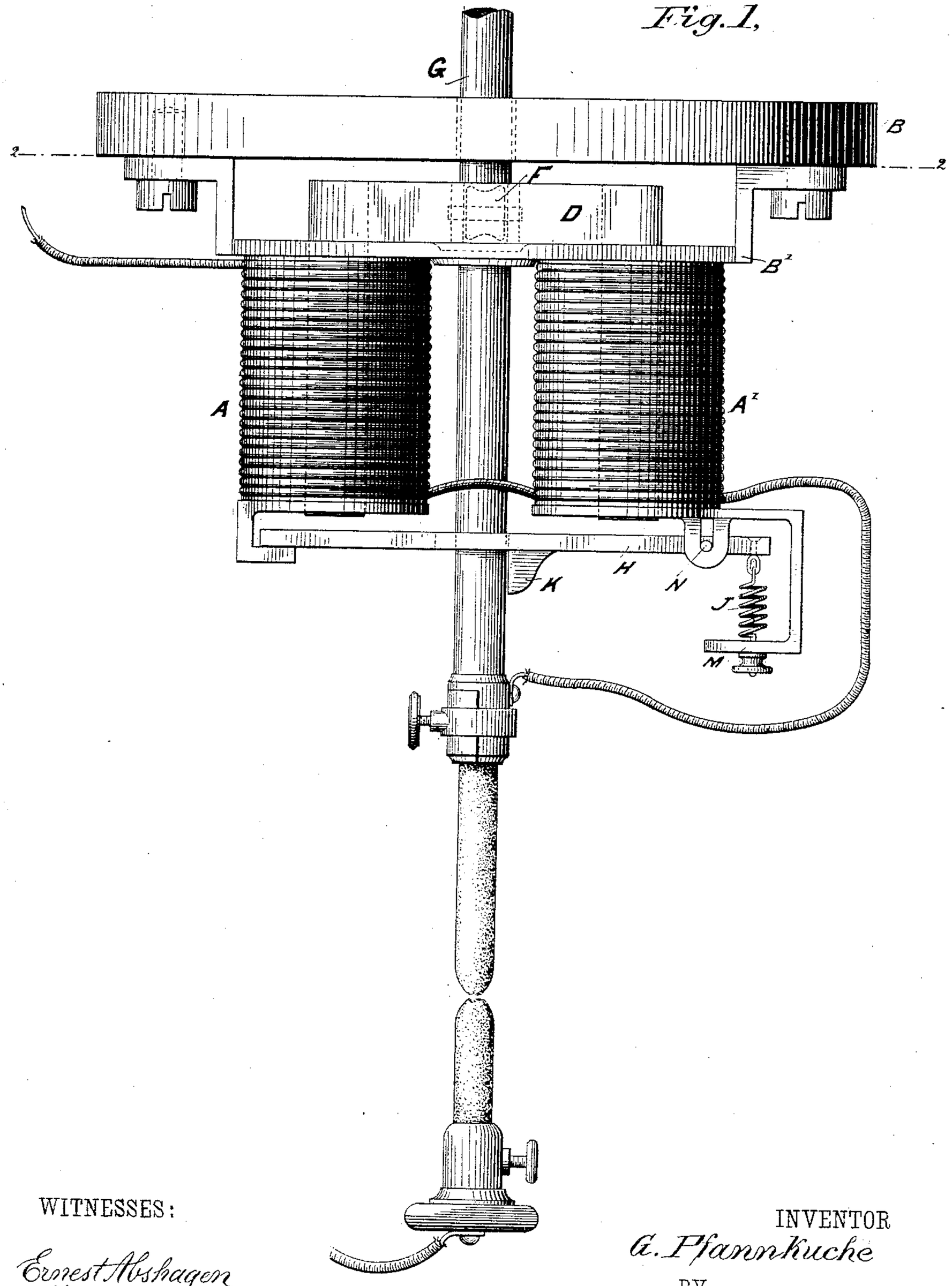
3 Sheets—Sheet 1.

G. PFANNKUCHE.

ELECTRIC ARC LAMP.

No. 348,927. Patented Sept. 7, 1886.

Fig. 1.



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(No Model.)

3 Sheets—Sheet 2.

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ELECTRIC ARC LAMP.

No. 348,927. Patented Sept. 7, 1886.

Fig. 2.

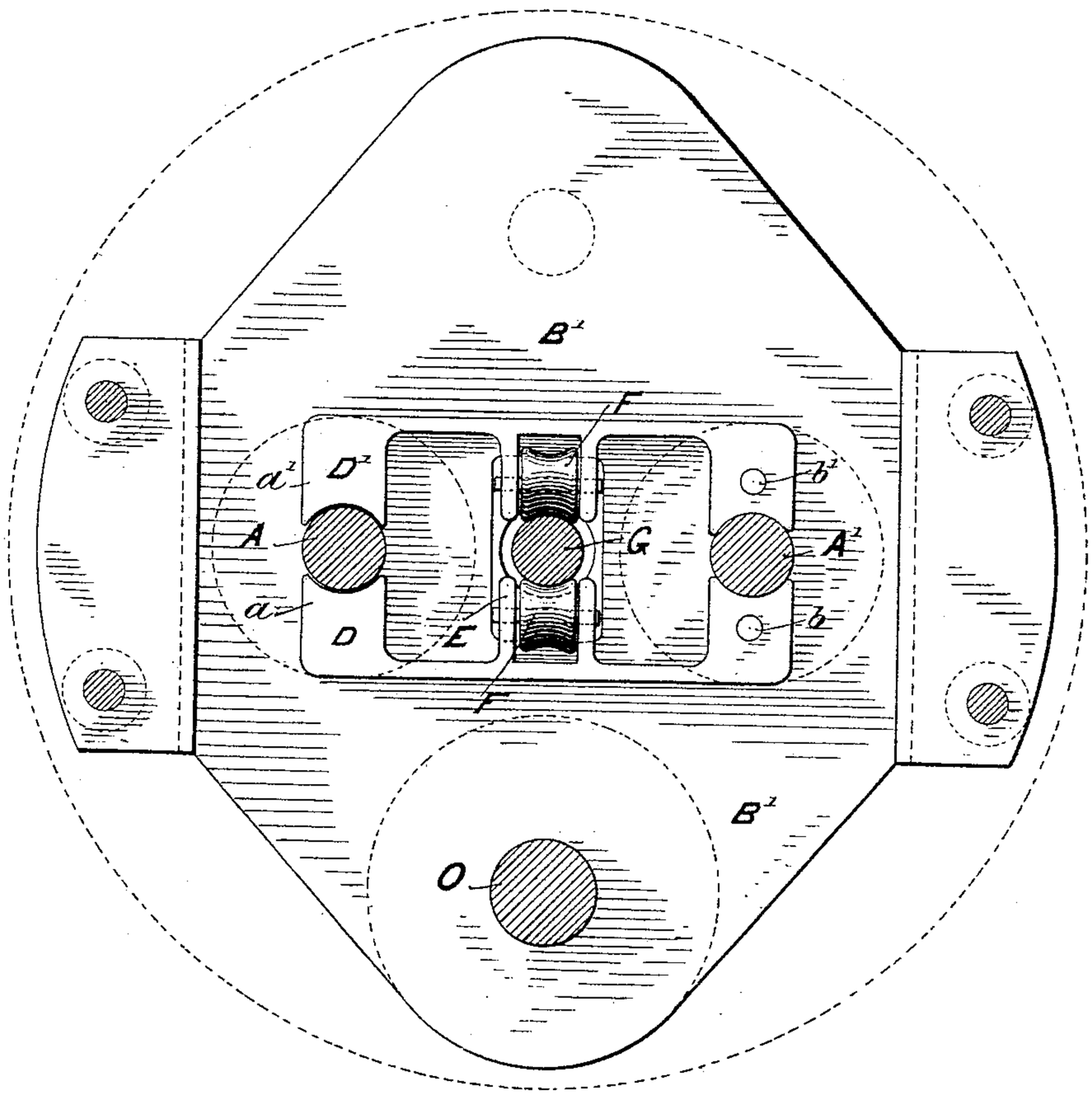
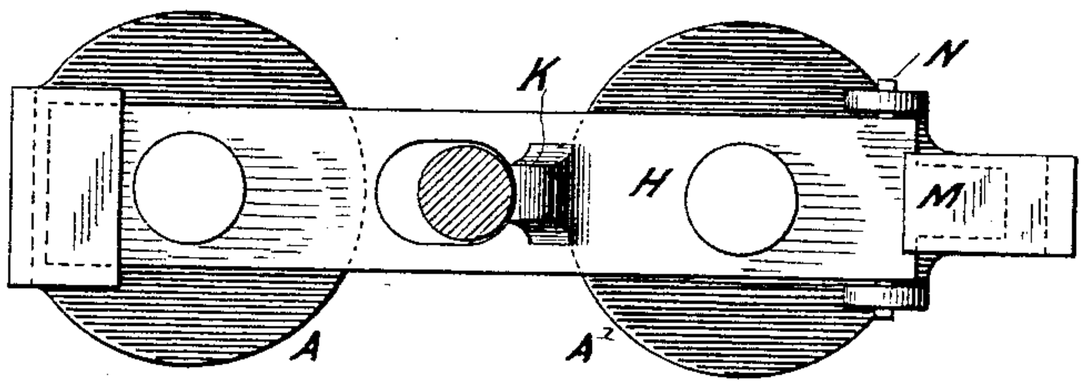


Fig. 3.



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3 Sheets—Sheet 3.

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ELECTRIC ARC LAMP.

No. 348,927. Patented Sept. 7, 1886.

Fig. 4.

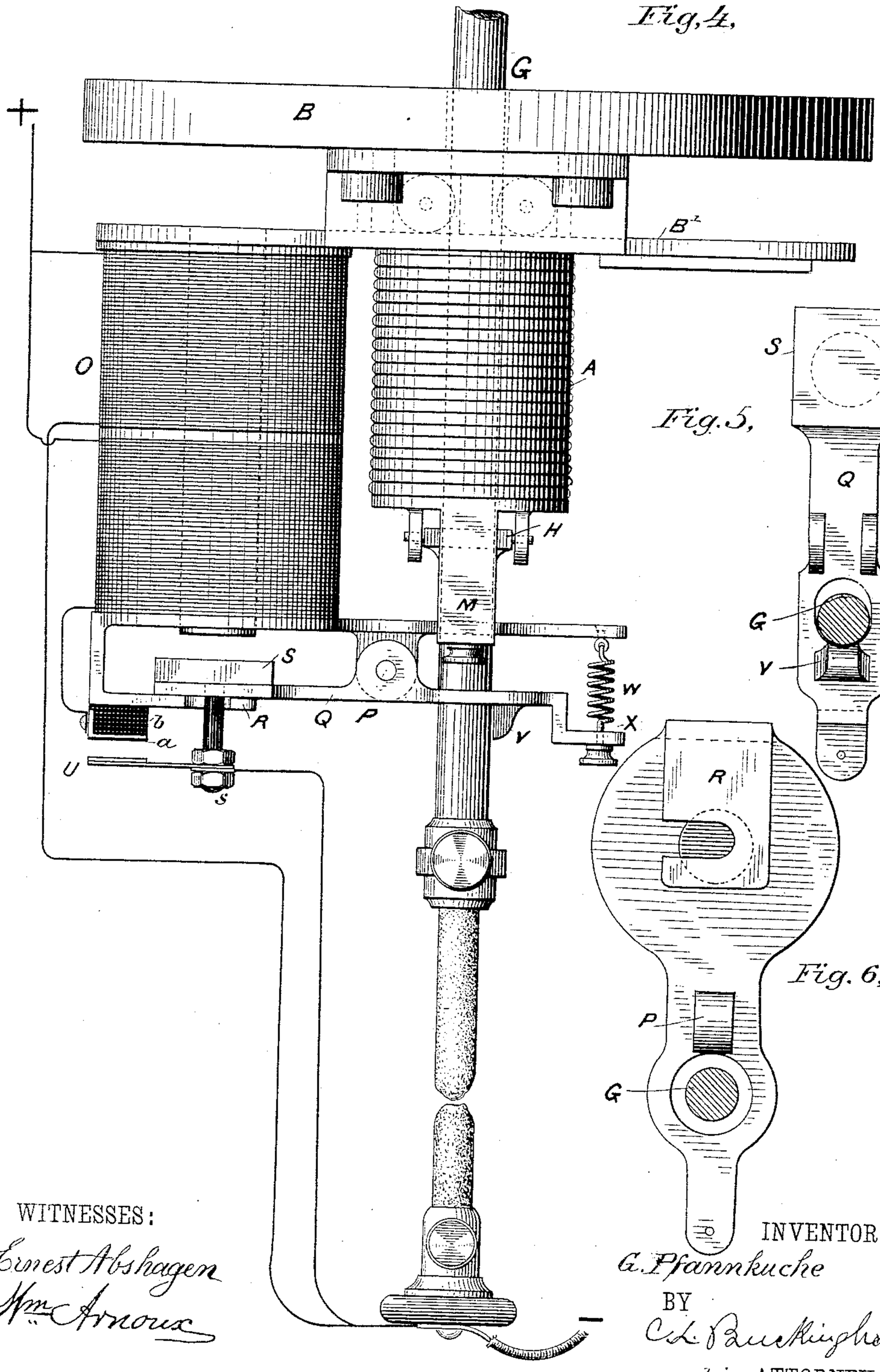

Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE.

GUSTAV PFANNKUCHE, OF HARTFORD, CONNECTICUT, ASSIGNOR TO THE SCHUYLER ELECTRIC LIGHT COMPANY, OF SAME PLACE.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 348,927, dated September 7, 1886.

Application filed August 26, 1884. Serial No. 141,514. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV PFANNKUCHE, of the city and county of Hartford, State of Connecticut, a citizen of the Austro-Hungarian Empire, have made a new and useful Invention in Electric-Arc Lamps, of which the following is a specification.

My invention comprises improvements in that class of arc lamps in which the carbon rods are normally in point-to-point contact preparatory to the drawing of the arc, and in which the arc is established by means of an electro-magnet in the arc branch, while the feeding of the carbon is effected by a step-by-step action through the agency of a high-resistance electro-magnet placed in a shunt branch or branches, which join the opposite poles of the lamp.

In my lamp the low-resistance or arc branch electro-magnet controls both a lifting-clutch to draw the arc and an electro-magnetic friction-clutch to sustain the carbon in the position to which it is set when the arc is established. The lifting-clutch is of the ring, toe, or other well-known form, and is so set that when no current is passing through the arc-branch magnet, the carbon-holder is free to slide therein. When, however, a current is first passed through the magnet, the clutch grasps the carbon-holder and both are lifted together until a sufficient amplitude of arc has been reached. At such point the clutch releases its hold upon the carbon-carrier, and said carrier would again be left free to slide through the clutch were it not that a second armature of the arc branch magnet at or a moment before the release of the lifting-clutch sets a second clutch, which retains the carbon-holder against the action of gravity from dropping. While the arc is at its normal length only a small portion of current flows through a shunt branch, but upon an abnormal increase of arc resistance enough current will flow through an arc branch to cause an electro-magnet therein to raise one and depress the other end of a pivoted armature-bar. To the depressed end of said bar is attached a clamping toe or ring clutch, which clutches against the carbon-holder and thrusts it downward any desired distance—say one twenty-fourth or one thirty-second of an inch.

In addition to the constantly-closed fine-wire shunt already referred to, there is a second fine-wire shunt, which is normally open, of the same resistance as the first, and wound upon the core of the feeding-magnet in a direction opposite to that of the first. The end of the armature-bar, which is raised by attraction of the feed-magnet, when at its extreme upward position causes the normally-open circuit-closer of the second shunt branch to close said branch, whereupon the effects of the currents in the two branches neutralize each other, and the armature of the feed-magnet is released and retracted, thus loosening the clutch which effected the first step of downward feed, thus leaving it free to repeat the operation, providing sufficient feed has not already been accomplished. As long as enough current continues to flow in the constantly-closed shunt branch to raise the armature of the feed-magnet, so long will a step-by-step feed continue.

Instead of a feed effected by a step-by-step movement, the second and normally-open branch may be omitted, and the feed accomplished by a single or partial movement of the feed-clutch. The armature would be attracted by a current of abnormal strength, and a feed effected which would continue until the length of arc had been properly reduced, when the current in the shunt branch would be so far weakened as to cause the armature to be retracted and the feeding suspended.

Another important feature of my invention consists of the manner in which I make my shunt branches. It is well known that the heat developed in an electrical conductor increases as the square of the current, and that the electrical resistance of a conductor becomes much greater with an increase of temperature therein. Any considerable change of current strength, therefore, in an ordinary shunt-conductor is accompanied by a material increase of its resistance. Material increase of resistance, however, contemporaneous with an increase of current strength, would not afford such a sensitive change of magnetic effect in the shunt electro-magnet as is necessary to effect the prompt operation of the feeding mechanism.

It is essential that slight changes of current strength in the shunt attending small variations of arc resistance should produce a maximum variation of magnetic effect. To this end, as material for shunt branch conductors in my lamp, I employ, preferably, a German-silver wire. Silver-platinum and gold-platinum alloys are even better than German silver, though their comparative expense will usually preclude their use. Wire of these materials not only has a suitably high resistance, but a resistance which, within the limits of ordinary thermal changes, is practically invariable, whereby the effect of the shunt-magnet, accompanying changes of resistance in the arc of the lamp, is not dissipated by simultaneous changes of resistance in said shunt.

I will now describe my invention by reference to the accompanying drawings.

Figure 1 is a front view of the electro-magnet and devices for establishing an electric arc and sustaining the carbon in suspension. Fig. 2 is a top view of the clutch devices for holding the carbon suspended after the arc has been established. Fig. 3 is a bottom view of the lifting-clutch for establishing the arc. Fig. 4 is a side view of the differential feed-magnet and the step-by-step feeding-clutch. Fig. 5 is a bottom view of the armature-feeding lever. Fig. 6 is a bottom view of the bracket attached to the lower portion of feed-magnet Q, in which is pivoted the feeding-lever.

The regulating apparatus of the lamp is supported beneath a base-board, B, to which it is rigidly attached by a broad bracket, B′. Two independent electro-magnetic cores, A A′, are set through plate B′, leaving free projecting ends between plate B′ and base-board B.

D D′ are two armature-bars, pivoted at *b b′*, respectively, and provided with hollowed-out projecting ends, to fit the ends of cores A A′, as shown in Fig. 2. The middle of each bar D D′ is provided with arms E, into which are journaled grooved rollers F, and between which the cylindrical carbon-carrier G may be clamped.

It is obvious that armature-bar D′ may be made stationary, while D alone is pivoted. With such an arrangement the carbon-carrier could be clamped between the grooved rollers F F.

Below the lower ends of cores A A′ an armature-bar, H, is supported. Said armature-bar is provided with an opening through which the carbon-carrier passes, and with a clamping-toe, K. The right-hand end of H is supported by a pivot, N, in a slotted bearing, and is normally held in its lowest position by a spring, J, whose tension is adjusted by set-screw M.

Instead of a toe-clutch, K, a clutch may be formed by a circular opening in bar H, whose diameter is a little in excess of that of the carbon-carrier. The coils of electro-magnets having cores A A′ are in the arc branch, and all the current which flows through the arc passes through those coils. When no current is flowing through the arc branch, the left ends of armature-bars D D′ will not be attracted by the core A, and carbon-carrier G will pass loosely between rollers F F. At the same time armature-bar H is in the position shown in Fig. 1. Upon passing a current through the arc branch magnets, however, the left end of H is first attracted to core A, the right end being retained by spring J, and clamping-toe K locks and raises the carbon-carrier G. After the left end of H is attracted to core A, the right end of H becomes strongly magnetic, and the increased attraction between H and core A′ suffices to overcome spring J. The attraction of the right end of H having been effected while the left end remains in contact with core A clamping-toe K is unlocked from the carbon-carrier, and if not otherwise sustained it would fall by the action of gravity. At the same time that the carbon-carrier is clamped, raised, and again unclamped, the free ends of armature-bars D D′ are attracted to the core A of the arc-magnet, thereby causing said armature-bars, which are pivoted above the ends of core A′, to tightly press grooved rollers F F against the carbon-carrier G as soon as or before said carrier is released by toe K after having been raised. While the lamp remains in operation armature H remains inactive and attracted to cores A A′, leaving the carbon free to descend under the action of gravity, except as it is retained by the pressure of rollers F F, which in the process of feeding is overcome by a step-by-step device, whose construction and operation is as follows: O is an electro-magnet upon whose core are differentially wound two equal coils, one of which is normally open or broken and the other constantly closed, and each of said coils forms a shunt of high resistance to the arc of the lamp. Armature-bar Q, pivoted at P, carries at one end an armature, S, a shank, *s*, and a contact-spring, *u*, which must be insulated from said bar Q. The opposite end of Q is provided with an opening for the carbon-carrier to pass through a clamping-toe, *v*, a retracting-spring, *w*, and an adjusting-screw, *x*. One of the shunt-branches, commencing at one—say the positive—pole of the lamp is wound upon electro-magnet O, and thence directly to the opposite or negative pole. The second shunt branch, beginning at the positive pole of the lamp is wound upon magnet O in a direction opposite to that of the first branch and thence to conducting-plate *a*, fixed upon a supporting-bracket, R, by means of an insulating-block, *b*. The second branch is normally broken between plate *a* and spring *u*. Spring *u* is directly connected to the negative pole of the lamp. When no current is flowing through the lamp, and at all times when the arc is at its normal length, the armature S remains retracted and clamp *v* in its extreme upward position. If, however, the arc resistance increases from the consumption of the carbons, more current will be diverted through the shunt branch until electro-magnet O raises

armature Q, thus depressing toe *v*. When S is unattracted, toe *v* does not clutch carbor-carrier G, but at the instant S is raised *v* grips the carbon-carrier and bears it downward a distance of one thirty-second or one twenty-fourth of an inch. When spring *u* comes in contact with *a*, the second shunt coil is closed, and the feed electro-magnet rendered neutral, whereupon the armature-bar is left under the influence of the retracting-spring *w*. It is thus obvious that as long as the current in the constantly-closed shunt branch is sufficiently strong, the operation of the attraction of S by electro-magnet O and its retraction by spring *w* upon the closing of the differential branch will be repeated and a step-by-step feed effected. The second and normally open shunt branch might be wholly dispensed with, and the feeding-clutch given such a range of movement that it could be operated to effect much more then the required feed. With such an arrangement, upon an increase of shunt-current, the carbon would be fed to its proper position, and there arrested to await further consumption.

Instead of two independent electro-magnets, as here shown, I might employ the one to solely operate H, and another to operate clutches D D′, though I prefer the form here described.

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

1. In an electric lamp, the combination of an electro-magnet, a carbon-holder, a clutch for first lifting and releasing its hold on the carbon-holder at the end of its upward movement, and an independent clutch for supporting the carbon-holder, both of said clutches being operated by said electro-magnet, substantially as described.

2. In an electric lamp, the combination of an electro-magnet, a carbon-holder, a clutch for lifting and releasing the carbon-holder, and an independent clutch for supporting the carbon-holder, both of said clutches being operated by said electro-magnet, and a second electro-magnet and feeding-clutch, substantially as described.

3. In an electric lamp, the combination of an arc branch electro-magnet, two clutches—one to establish the arc and then release its hold and the other to support the carbon-holder upon the release of the lifting-clutch—both of said clutches being controlled by said electro-magnets, and a shunt branch electro-magnet, and a clutch controlled thereby to feed said carbon-holder, substantially as described.

4. In an electric lamp, the combination of a carbon-holder, an electro-magnet, a clutch-armature whose ends are successively attracted to lift said carbon-holder and unlock the lifting-clutch, and a second armature and clutch controlled by the same electro-magnet for supporting the carbon-holder against the action of gravity upon the unlocking of the lifting-clutch.

5. The combination of carbon-holder G, arc branch, electro-magnet, lifting-armature H, and armature-bar D, controlled by the same electro-magnet for supporting the carbon-holder against the action of gravity, substantially as described.

GUSTAV PFANNKUCHE.

Witnesses:
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JOHN TREGONING.