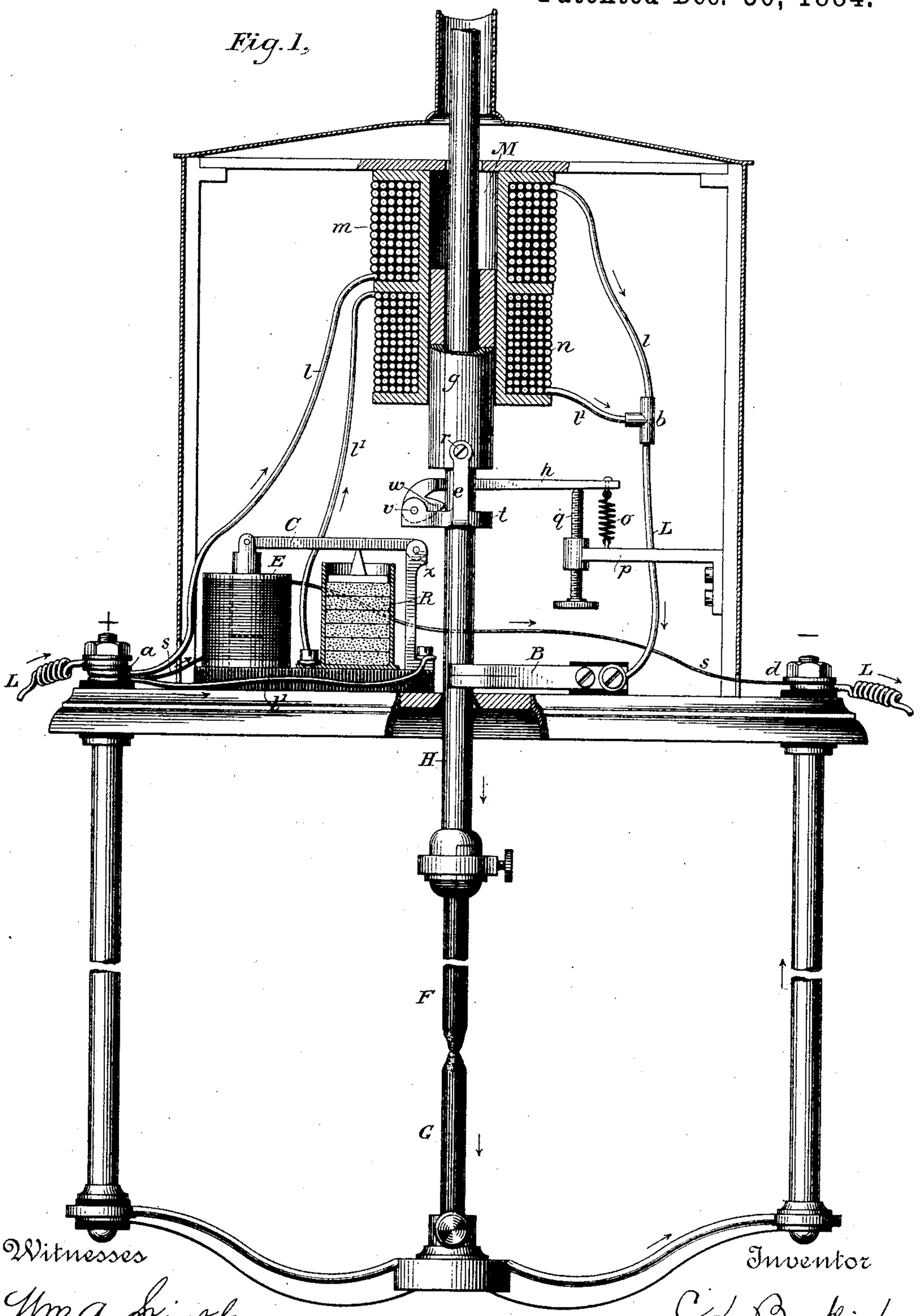
(No Model.) 2 Sheets—Sheet 1.

C. L. BUCKINGHAM.

REGULATOR FOR ELECTRIC LAMPS.

No. 310,119. Patented Dec. 30, 1884.

Fig. 1.



Witnesses

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(No Model.)

2 Sheets—Sheet 2.

C. L. BUCKINGHAM.

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Fig. 2.

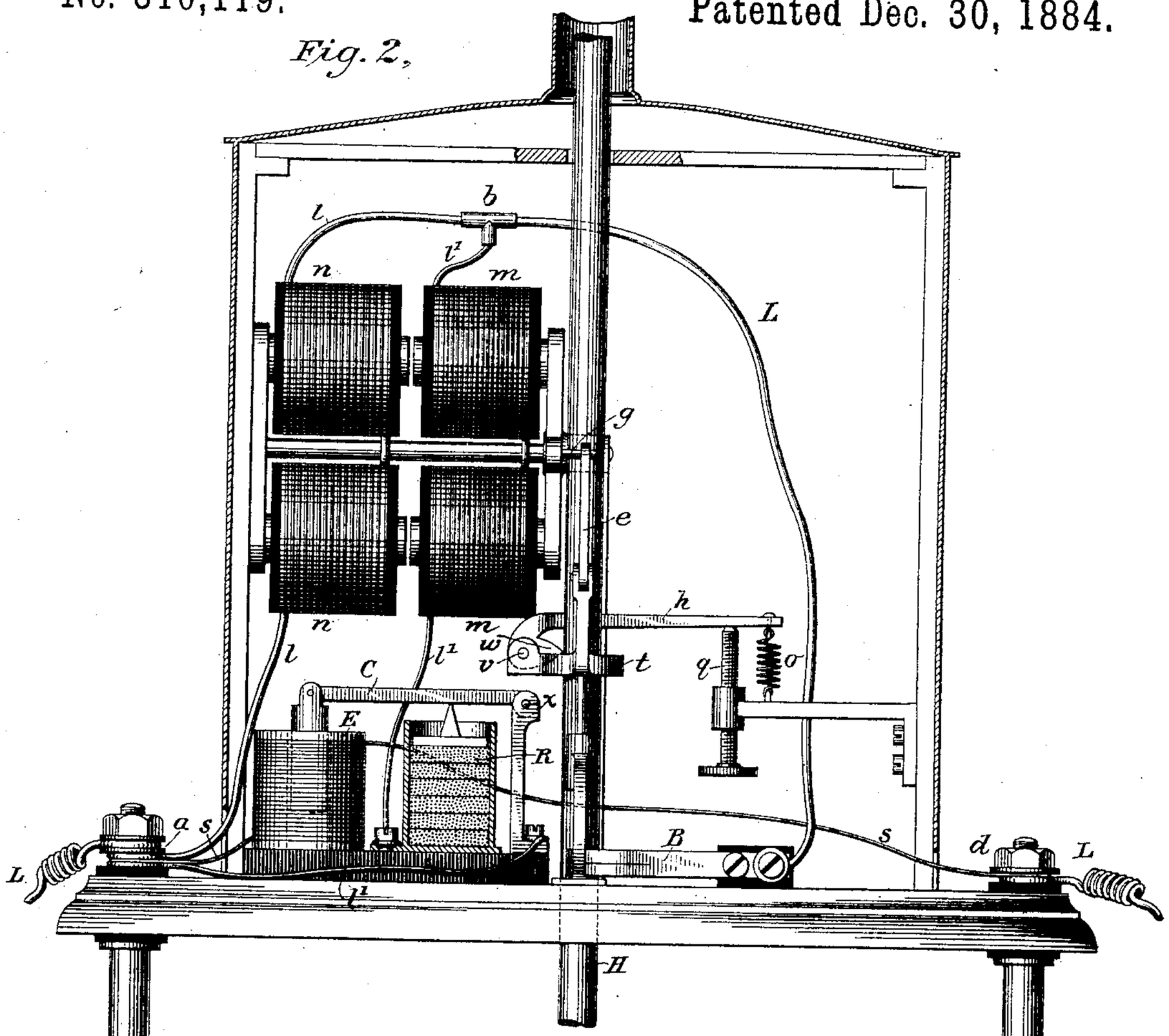
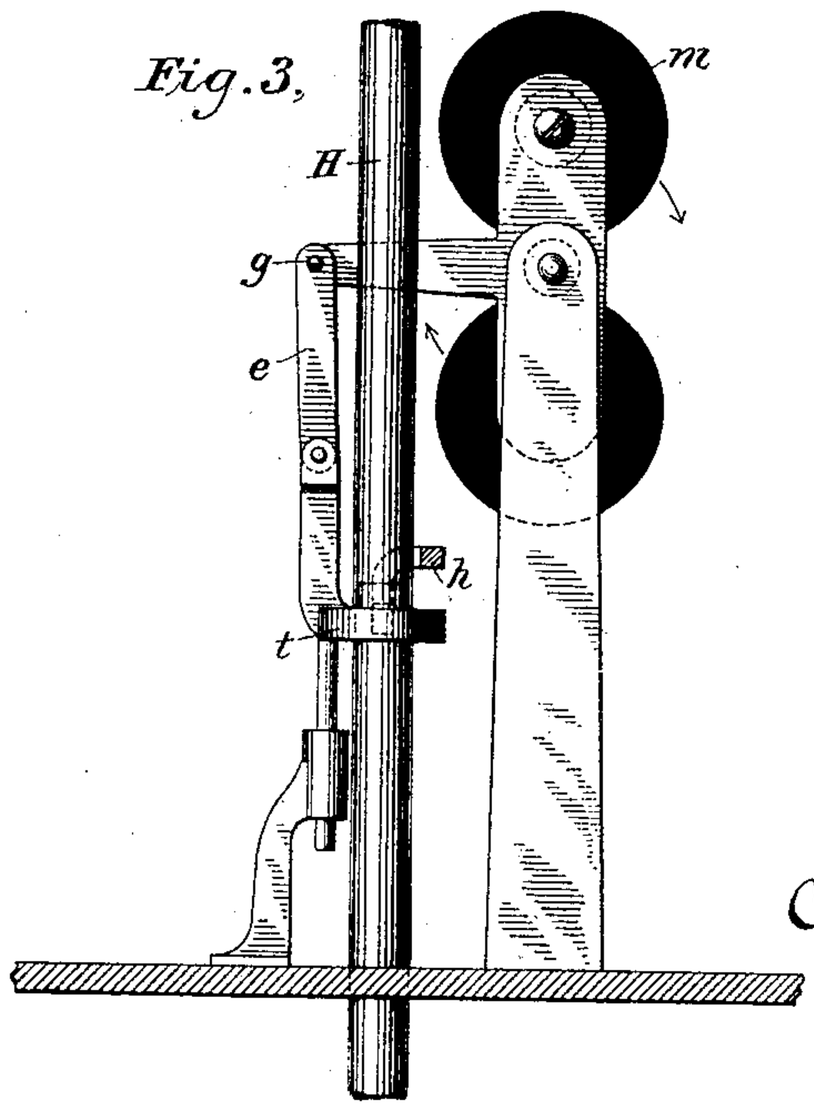


Fig. 3.



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UNITED STATES PATENT OFFICE.

CHARLES L. BUCKINGHAM, OF NEW YORK, N. Y.

REGULATOR FOR ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 310,119, dated December 30, 1884.

Application filed May 5, 1884. (No model.)

To all whom it may concern:

Be it known that I, CHARLES L. BUCKINGHAM, of the city, county, and State of New York, a citizen of the United States of America, have invented a new and useful Improvement in Regulators for Electric Lamps, of which the following is a specification.

The various types of existing differential lamps are provided with two coils. One of said coils, commonly known as the "coarse-wire coil," forms a part of the arc branch, and serves to separate the carbon electrodes of the lamp to establish an arc, while the other coil, commonly known as the "fine-wire coil," and being included in a shunt to the electric lamp, acts to overcome the force of the coarse-wire coil and to cause the electrodes of the lamp to be fed together under the positive action of a spring, gravity, or other agent. I employ, instead of a single coarse-wire coil, two coarse-wire coils, forming parts of two branches which begin and reunite on the same side of the arc. Said coarse-wire coils are wound either differentially upon a single electro-magnetic core or upon independent cores in such a manner as to afford an opposing or differential action in respect to each other. One of the branches is of constant electrical resistance, while the resistance of the other is readily adjustable, and adjustment in its resistance is effected by an electro-magnet whose coils form a part of a high-resistance shunt around the lamp. Normally, very little current flows through the shunt branch, and at the same time very little, if any, current passes through that one of the coarse-wire coils embracing the variable resistance, as said resistance is then at its maximum and many times greater than that of the other branch. Nearly the entire current of the main circuit, under this condition, is forced through the coarse-wire coil whose branch is of a constant resistance, and thereby the electrodes are held apart to form an arc. When, however, the electrodes are consumed to an extent to occasion an increased arc resistance, more current is diverted through the fine-wire shunt and to an extent proportional to the increase of arc resistance. The increase of current in the shunt branch causes the armature of the electro-magnet therein to automatically decrease the resistance of the branch of one of the coarse-wire coils, thereby permitting more current to pass through it, which acts to neutralize the effect of the current in the other coarse-wire coil. If the two coarse-wire coils are wound upon the same core, the resultant electro-magnetism may thus be reduced, and, if need be, rendered *nil*. If the two coarse-wire coils are wound one upon stationary cores and the other upon movable electro-magnetic cores normally, the poles of the movable core by inductive effects will be held against the action of a spring or gravity opposite to or in the immediate proximity of the poles of the stationary core, and upon a decrease of the variable resistance in one of said branches magnetism will be induced which will neutralize the effects whereby the stationary and movable cores are held close to each other, thereby permitting the retracting force acting upon the movable cores to cause the carbons of the lamp to be fed together. It is obvious that in the old types of differential lamps a very considerable increase of arc resistance must occur before enough current will be diverted through the fine-wire coil to effect a feed of the electrodes. With my arrangement, however, it is apparent that an increase of current, although too small to in any considerable degree neutralize the effect of the strong arc branch current, will yet be sufficient to actuate an armature of the shunt electro-magnet for the purpose of removing a part or the whole of the variable resistance of one of the branches.

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

Figure 1 shows a regulator whose feed-magnet is provided with an axial armature, and upon whose core are differentially wound two coarse-wire coils. Fig. 2 represents a magnet system for the feed-regulator, consisting of a stationary and a movable electro-magnet whose coils respectively form parts of the two multiple-arc branches of the main line. Fig. 3 is a side view of the oscillating feed-magnets and feed-clutch apparatus.

As shown in Fig. 1, L is a main line which is divided at points *a* and *b*, both on the same side of the arc, into two branches, *l* and *l'*, whose normal resistances may be about as one

to ten, including, respectively, coils *m* and *n* of electro-magnet M. Coils *m n* are wound differentially upon the core of electro-magnet M, whereby the current flowing through branch *l'* tends to neutralize the magnetic effects in the electro-magnet M due to the current in branch *l*. Branch *l* is of constant electrical resistance. Branch *l'* completes its circuit through lever C and an adjustable resistance, R, thus affording in said branch a highly-variable conductivity. Resistance R is made up of a pile of carbon plates laid flatwise upon one another, and the resistance of the pile is varied by a variable pressure, to which it is subjected by means of electro-magnet E.

s is a shunt of high resistance joining the opposite poles of the electric lamp and including the fine-wire coils of electro-magnet E. Electro-magnet E is provided with an axial armature attached to the armature-lever C, which is pivoted at point *x*. When no current is flowing through shunt *s*, the resistance of branch *l'* is at its maximum, since at that time the armature of the shunt-magnet is unattracted and the armature-lever C bears only with a light pressure upon the plates of the carbon resistance R. If the current strength in shunt *s*, however, is increased, armature-lever C compresses the carbon resistance R until its conductivity is greatly increased. The wire of coil *n* should be somewhat smaller than that of coil *m*, and their respective amounts of wire should be so proportioned that their resultant magnetic effects when the resistance of R is reduced to its minimum will be almost *nil*.

Although the maximum resistance of R may be great as compared with the resistance of branch *l*, it need not exceed one ohm, for even with that small amount not enough current would flow through its branch to cause the heating of the carbon pile, owing to the still smaller resistance of the branch *l*. If the resistance of R is, say, one ohm when no pressure is applied, it is obvious that only a small force would be required to reduce the resistance to an extent to cause much more current to flow through its branch.

H is a carbon-holder carrying carbon electrode F, and *g* is the axial armature of differential magnet M, through an axial opening of which the carbon-holder passes. A stirrup, *e*, carrying a supporting-ring, through which the carbon-holder also passes, is pivoted to the axial armature at *r*, and a lever, *h*, is pivoted to supporting-ring *t* at *v*. Lever *h* is provided with a clamping-toe, *w*, for engaging with or releasing the carbon-holder H, and is also provided with a spring, *o*, attached to a rigid support, *p*, which carries a set-screw, *q*, for arresting the downward movement of lever *h*. When the axial armature G is lifted by electro-magnet M, the supporting-ring *t* is raised, carrying with it the pivoted support *v* of lever *h*, and the opposite end of *h* is retained in a nearly-constant position by spring *o* until toe *w* is firmly clamped against the carbon-holder, whereupon said lever is then lifted against the tension of spring *o* from its seat on set-screw *q*. Under this condition carbon F is lifted from carbon G to form an arc between their points. If while lever *h* is lifted from set-screw *q* the axial armature *g* is lowered, said lever *h* will first strike set-screw *q*, and upon a further lowering of the axial armature lever *h* will be tilted until the toe *w* releases carbon-holder H, thereby permitting the carbon points to feed together. The main circuit L divides at point *a* into three branches, the shunt-branch *s* and branches *l l'*, which are reunited at point *b* into the single-arc-branch conductor connecting with brush B and the carbon-holder H. The arc and shunt branches reunite at point *d* at the opposite side of the arc.

The operation of the lamp is as follows: When no current is flowing upon the main line, the carbon points F and G rest in contact, and the resistance of branch *l'* in respect to that of *l* is comparatively great. If a current of normal strength is now passed over the main line, nearly the entire current will flow through branch *l*, causing the carbon points to be separated to form an arc. If, however, the resistance of the arc becomes too great, considerable current will flow through shunt *s*, which immediately removes resistance from branch *l'* until the magnetism due to coil *n* nearly neutralizes that of *m*, thus permitting axial armature *g* to drop until lever *h* strikes set-screw *q* and toe *w* releases carbon-holder H. When by this means a proper feed has occurred, the arc-branch resistance will have been so far reduced that very little current will flow through the shunt branch, and the resistance of branch *l'* will be so far increased that coil *n* will no longer produce any considerable neutralizing effect.

Fig. 2 shows an apparatus which is modified in respect to that of Fig. 1 only in the form of the feed-magnet arrangement.

n is the coil of a stationary electro-magnet whose horizontal cores are in the same vertical plane.

m is the coil of an oscillating electro-magnet whose cores are pivoted upon a horizontal axis. When little current flows through coil *m*, the cores of *n* induce opposite magnetism in the cores of *m*, and the cores of *m* and *n* are attracted and held opposite each other. The current in branch *l'* induces in the cores of *m* magnetism of the same polarity as that in the cores of *n*, thereby neutralizing in the cores of *m* magnetism which is induced in them by the cores of *n*, thus permitting the cores of *m* to oscillate and lower supporting-ring *t*, which is connected to said electro-magnet by the jointed arm *e* and pin *g*, until the carbon-holder is unclamped by toe *w* and a carbon-feed effected.

Instead of a resistance, R, composed of a series of compressible carbon plates, I may

use any well-known form of rheostat; but by means of the form of adjustable resistance here shown the conductivity of *l'* may be gradually increased and decreased. Instead of an adjustable resistance, I of course may employ armature-lever C to open and close branch *l'* without any intermediate change of resistance in said branch; but under such conditions of operation the magnetic effects in the lifting-magnet would always be either neutral or at their maximum.

My invention is equally applicable to all forms of differential lamp-regulators. I therefore do not desire to limit myself to the arrangements of magnets for controlling the carbon-feed herein shown.

The relative resistance of branches *l* and *l'* and the size and length of wire employed in each branch may be greatly varied. It is necessary, however, that they should be so proportioned that the magnetic effects of the two coils may be rendered substantially equal when the resistance of R is reduced to a minimum.

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

1. In an electric lamp, two main-line branches including opposing electro-magnetic coils, an adjustable resistance in one of said branches, and a shunt embracing an electro-magnet joining the opposite poles of the lamp, for controlling said adjustable resistance.

2. In an electric lamp, two branches which begin and reunite at one side of the electric arc, electro-magnet coils in each of said branches, an adjustable resistance in one of said branches, and an electro-magnet in a shunt around the lamp, for controlling said adjustable resistance.

3. In an electric lamp, two main-line branches beginning and terminating on the same side of the arc, one of which is of constant resistance and embraces the electro-magnetic coils for establishing an arc, and the other of variable resistance, which embraces the electro-magnetic coils, for causing the carbons to feed.

4. In an electric lamp, the combination of branches *l l'*, adjustable resistance R, differential coils *m n*, shunt *s*, and electro-magnet E.

5. In an electric lamp, the combination of branches *l l'*, differential coils *m n*, shunt *s*, and electro-magnet E.

6. In an electric lamp, a coarse-wire branch, *l'*, including feed-coil *n* and an adjustable resistance, R, as set forth.

7. In an electric lamp, the combination of branch *l'*, including coil *n*, and resistance R, and shunt *s*, including means for controlling said resistance.

Executed April 22, 1884.

CHARLES L. BUCKINGHAM.

Witnesses:

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S. S. WATTERS.