(No Model.)

# G. A. MAYO.

## ELECTRIC LAMP.

No. 338,352. Patented Mar. 23, 1886.

Fig: 1.

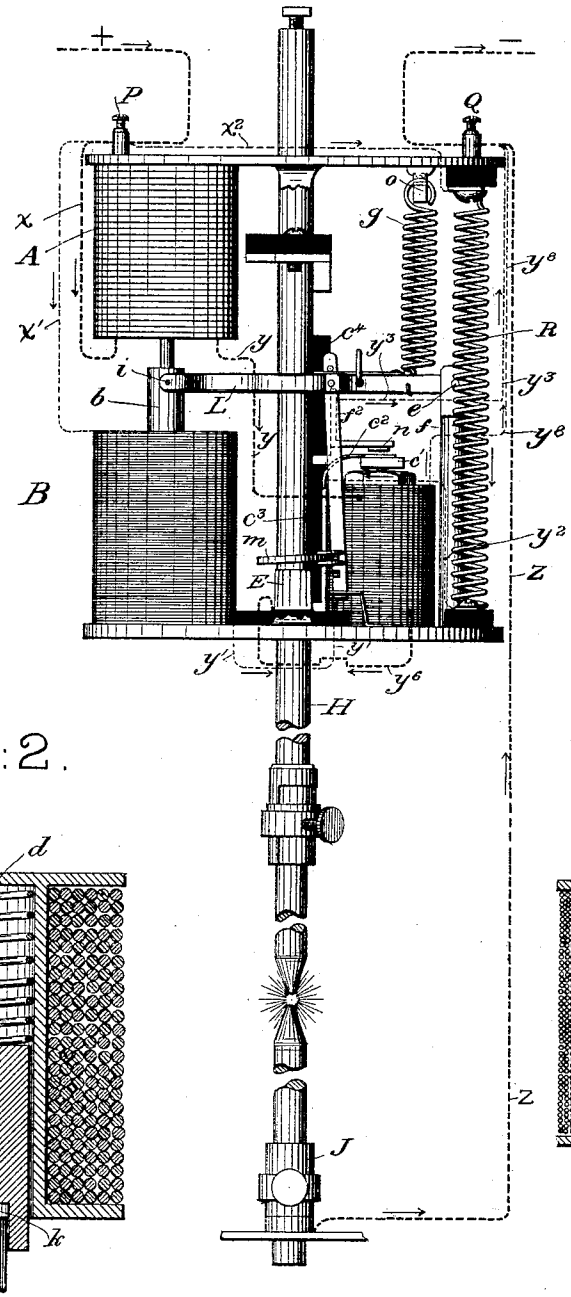



Fig: 2.

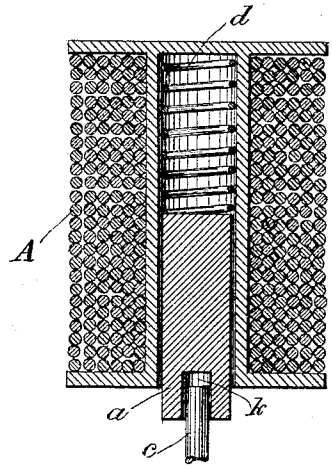
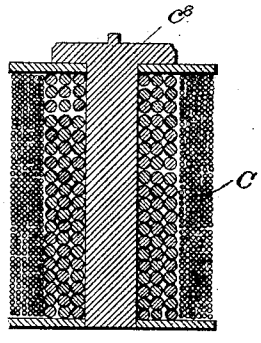



Fig: 3.




Witnesses.

John F. Nelson.

John F. C. Brinkerhoff

Inventor.

George A. Mayo.

by Crosby & Gregory Attys

# UNITED STATES PATENT OFFICE.

GEORGE A. MAYO, OF LYNN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE MAYO ELECTRIC MANUFACTURING COMPANY, OF BOSTON, MASS.

## ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 338,352, dated March 23, 1886.

Application filed May 4, 1885. Serial No. 164,270. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE A. MAYO, of Lynn, county of Essex, State of Massachusetts, have invented an Improvement in Electric Lamps, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The object of my invention is to provide an electric lamp with a feed-controlling apparatus whereby the feed of the carbons may be regulated to reduce to a minimum the variations in the length of the arc, and whereby great or extreme variations in the strength of the current in the lamp may take place without affecting the action of the lamp.

My invention also provides an electric lamp with an automatic safety or cut-out circuit, operated by the differential action of the currents in the main and shunt circuits.

In accordance with my invention I employ two solenoids—one of which is in the main circuit and the other in a shunt-circuit around the carbons—and I also, to co-operate with both circuits, provide a magnet which is wound next to its core with coarse wire, through which passes the main current, the said coarse wire being enveloped or cased with fine wire wound in a direction opposite to that of the coarse wire, the said fine wire being included in the shunt-circuit.

The magnet wound as described will be hereinafter designated as the "differential magnet."

The solenoid in the main circuit is wound with coarse wire, and has within its hollow cylinder an iron or steel core, and a spring which is placed above and presses upon the said core, and the solenoid in the shunt-circuit is wound with fine wire, and is provided with an iron or steel core which has securely fastened to it a lever and a rod made of a non-magnetic material. The lever referred to is pivoted in an upright or standard, and has a spring connected to it between its fulcrum and the iron or steel core, and the said spring is hooked into an arm which is securely attached to the frame of the lamp, and the lever also has secured to it a carbon-holding clutch which may be of any of the various forms in use. A metallic ring or brush which encircles and bears against the carbon-holding rod, thereby establishing the main circuit through the said rod, is insulated from the frame of the lamp. The differential magnet is provided with an armature which is secured to a somewhat stiff spring, the said spring being fastened to an insulated block, which is secured to the frame of the lamp. The armature of the said magnet, when not attracted, is retracted by a spring, the armature then closing a safety or cut-out circuit around the carbons of the lamp, the said armature forming one terminal of the said circuit, the other terminal being placed above the said armature and forming the back stop therefor, and being rigidly fastened to an insulating-block connected to the frame of the lamp. A resistance-coil fastened to blocks which are insulated from the frame of the lamp forms a part of the safety or cut-out circuit.

My invention consists of a main or circuit-starting solenoid wound with coarse wire and having within its hollow cylinder an iron or steel core and a spring to act upon the said core, combined with a feed-controlling apparatus consisting of a solenoid wound with fine wire and located in a shunt-circuit around the carbons, the said solenoid having an iron or steel core, to which is securely fastened a rod of a non-magnetic material, and with a pivoted lever having a carbon-holding clutch of ordinary construction connected thereto, and a retracting-spring joined to an arm which is fastened to the frame of the lamp, the said spring acting to move the lever in a direction opposite to that in which it is moved by the action upon its core of the shunt-circuit solenoid when magnetized, and in a direction opposite to that in which it is moved by the action of the spring upon the core of the solenoid in the main circuit.

My invention also consists in an electric lamp of two solenoids—one in the main and the other in the shunt circuit—combined with a differential magnet and its armature, arranged, when not attracted, to close a safety or cut-out circuit, a part of the wire of the dif-

ferential magnet being in circuit with the main solenoid, and another part of the said wire in the circuit with the shunt-solenoid, thus enabling the safety or cut-out circuit to be brought into operation when the arc is abnormally long.

My invention further consists of a differentially-wound magnet having its coarse wire in the main circuit and its fine wire in the shunt-circuit, combined with its armature, which forms one terminal of a safety or cut-out circuit, and with a spring, and with a piece of metal fastened to an insulated block supported by the frame of the lamp and forming the other terminal of the said safety-circuit, and being at the same time the back-stop for the said armature, the said metal piece being placed above the said armature, the latter, when moved by the spring when the strength of the current in the shunt-circuit is sufficient to substantially demagnetize the core of the differential magnet, co-operating with the said piece of metal constituting the terminal to establish the safety or cut-out circuit.

Figure 1 is a diagram of an electric lamp embodying my invention, the parts being shown as if the lamp were in operation. Fig. 2 is an enlarged sectional detail of the solenoid in the main circuit, showing its spring and core, together with part of the rod which is secured to the core of the shunt-solenoid, the said rod being shown as entering the recess of the core of the solenoid in the main circuit, the spring, core, and rod being in the positions occupied by them when the lamp is burning; and Fig. 3 is an enlarged sectional detail of the differential magnet, showing the coarse and fine wire.

The main or circuit-starting solenoid A is wound with coarse wire, and has within its hollow cylinder an iron or steel core, *a*, (see Fig. 2,) preferably provided with a recess, *k*, at one end, to receive the brass or other non-magnetic rod, *c*, and a spring, *d*, placed above and acting upon the said core *a*, thereby forcing it down upon the said rod *c* when the lamp is not in circuit, the said spring *d* resisting the action of the spring *g* at all times, and also resisting the attractive force of the solenoid A for its core *a* when the lamp is in circuit.

The shunt-solenoid B is wound with fine wire, and forms one part of the feed-controlling apparatus. The solenoid B has an iron or steel core, *b*, to which is securely attached at its upper end the rod *c*, referred to, it being preferably of brass, the said rod extending upward and entering the recess *k* in the core *a*, the end of the rod *c* terminating near the bottom of the recess in the core *a* when the arc is established, as shown in Fig. 2. The core *b* of the solenoid B has pivoted to it at *i* the lever L, preferably yoked around the said core, the said lever being pivoted at *e* in the upright or standard *f* of the lamp-frame, and having connected to it a lever, $f^2$, to actuate a carbon-holding clutch, *m*, of ordinary construction. The lever L has attached to it a spring, *g*, which is hooked into an arm, *o*, fastened to the frame of the lamp. The spring *d*, acting on the core *a*, is normally of sufficient strength to cause the said core, in the absence of the current from the lamp, to depress the rod *c*, and with it the lever L, overcoming the spring *g*, permitting the carbon-holding clutch to be placed in its lowest or horizontal position, and leaving the carbon-holding rod free to descend by gravity. When the lamp is in operation, the solenoid A becomes magnetized and attracts its core up within itself, thus compressing the spring *d* and permitting the spring *g* to assume control of the lever L and lift the carbon-holding clutch and the carbon-holding rod H and properly separate the carbons to form the arc. The spring *g* also serves to keep the lever L lifted, to prevent the core *b* from dropping to the bottom of the hollow cylinder of the solenoid B when the lamp is not in circuit.

The core $c^8$ of the differentially-wound magnet C (shown in section in Fig. 3) is wound first with coarse wire and then with fine wire in an opposite direction to that in which the coarse wire is wound. The coarse wire of the said magnet is connected by the wire *y* to the solenoid A and by the wire $y^6$ to the metallic brush E, which bears against and forms the electrical connection between the said differential magnet and the carbon-holding rod H, thereby establishing the main circuit through the said carbon-holding rod, the said brush being insulated from the frame of the lamp. The fine wire of the said magnet C is connected by the wire *y'* to the solenoid B, and by the wire $y^8$ to the binding-post Q, thereby putting the said magnet into the shunt-circuit around the carbons.

The armature *c'* of the magnet C, fastened to a spring, $c^2$, which is secured to an insulating-block, $c^3$, attached to the frame of the lamp, forms one terminal of a circuit-closer, the other terminal, *n*, being placed above the said armature, and securely fastened to the insulating-block $c^4$, the said armature and terminal *n* forming the circuit-closer for the safety or cut-out circuit. The negative carbon-holding rod J, also of usual construction, is connected by the wire *z*, which runs through a hollow tube, such as is used for the same purpose in ordinary lamps and not herein shown, to the binding-post Q, where it unites with the wire $y^8$, running from the magnet C to the said post, and with the wire $y^5$ from the terminal *u*.

Operation: When the lamp is not in circuit, the core *a* of the solenoid A is forced downward by the spring *d* until it presses upon the rod *c*, fastened to the upper end of the core *b* of the solenoid B, and forces the said core *b* down within the solenoid B. As the core *b* moves down, it also brings with it the lever L and the clutch connected thereto, thus releasing the grip of the said clutch on the carbon-holding rod and allowing the same to slip down

until it makes contact with the other carbon. The current enters the lamp by way of the binding-post P, where it divides, one part going through the main circuit $x\ y\ y^6\ z$, which is traced through the solenoid A, and the coarse wire of the magnet C to the carbon-holding rod H by means of the metallic brush E, and thence through the carbons to the negative binding-post Q. Another part of the current $x'\ y\ y^8$ passes through the solenoid B and the fine wire of the magnet C to the post Q, this circuit being a shunt-circuit around the carbons. A third portion of the current passes through the circuit $x^2$ R $y^2\ y^3$ when the terminals $c'$ and $n$ are in contact, the latter circuit being the safety or cut-out circuit. As the current passes through the solenoid A, it magnetizes the said solenoid, causing it to attract its core $a$ up within its hollow cylinder against the force of the spring $d$. When the core $a$ moves upward, it removes the pressure on the core $b$ of the solenoid B, and allows the spring $g$ to lift the lever L and the clutch $m$ connected thereto, thereby causing the said clutch to grasp the carbon-holding rod H and to lift it up, thus establishing the arc of the lamp, as shown in Fig. 1. As the carbons are consumed and the resistance of the arc grows correspondingly greater, more current flows through the solenoid B, increasing the magnetism thereof, thereby causing it to attract its core $b$ within its hollow cylinder, thus overcoming, to a certain degree, the upward pull of the spring $g$. As the core $b$ moves down within the solenoid B, the lever L attached thereto is moved down, thereby causing the clutch $m$ connected with it to move down and to release its hold upon the carbon-holding rod H, and to allow the said rod to feed downward by the force of gravity. As the length of the arc is diminished, the current flowing through the shunt-solenoid B is correspondingly diminished, weakening the attractive force of the said solenoid for its core $b$, and allowing the spring $g$ to move upward the lever L and clutch $m$ connected thereto, thereby establishing the arc at its normal length. When the arc is in its normal condition, the attractive force of the solenoid B for its core $b$ balances the upward pull of the spring $g$. As the arc becomes abnormally small, the attractive force of the solenoid B is weakened and the spring $g$ lifts the rod up sufficiently to establish a normal arc. When the arc becomes abnormally great, the attractive force of the solenoid B increases and pulls down the core $b$ and the lever L and clutch $m$ connected thereto, thereby releasing the carbon-holding rod and allowing it to feed until a normal arc is again established. Thus it will be seen that a very small increment or decrement of the current flowing through the solenoid B acting upon the core $b$ (the said action being transmitted to the spring $g$ by the lever L) causes the variations from the normal in the length of the arc to be reduced to a minimum. As a very small part of the current flowing through the lamp passes through the feed-controlling solenoid B in the shunt-circuit, great variations in the strength of the current flowing through the lamp do not affect the action of the lamp. In actual practice it has been demonstrated that the current flowing through the lamp can be reduced from ten to six ampères without any effect upon the lamp, whereas such a reduction in the strength of the current in the ordinary lamp would extinguish it.

A lamp having the construction herein described may be used practically with currents varying in strength, as stated.

It is obvious that the lamp is adapted for any current having the maximum or minimum strength above stated, thus enabling the same lamp to be used equally well in circuits having currents of different intensity, whereas as heretofore lamps to work in a current of one strength have not been suited to work equally well in currents of other strengths.

A lamp constructed as shown by me may be employed where changes in current strength vary for certainly four ampères. Inasmuch as the currents of the main and shunt circuits pass through the differential magnet C in opposite directions, it is evident that the two currents tend to neutralize each other. When the arc is a normal one, the main current in the magnet C prevails and the armature $c'$ is attracted, thereby opening the cut-out circuit $x^2$ R $y^2\ y^3$ at $c'$; but when the arc becomes very great, by reason of a breaking of a carbon or other like cause, the current flowing through the shunt-circuit becomes stronger and continues to increase in strength until it has neutralized the main current flowing through the differential magnet C, at which time the armature $c'$ is retracted by its spring $c^2$, which is adjusted so as to act when this neutral point in the magnet C has been reached, thereby closing the circuit $x^2$ R $y^3\ y^5$, and thus cutting out the lamp.

From the foregoing statement it becomes evident that the automatic cut-out of the lamp is controlled by the differential action of the currents in the main and shunt circuits, whereby the said lamp is cut out when this differential action is zero—that is, when the main and shunt circuit currents flowing through the magnet C are equal in effect.

I claim—

1. The main-circuit solenoid and its loose core and spring, and the shunt-circuit solenoid and its core provided with the rod $e$, to be engaged by the core of the main-circuit solenoid when the lamp is not in circuit, and with a spring-held lever, a clutch, and a carbon-holding rod to be moved by the clutch to operate substantially as described.

2. In an electric lamp, the main-circuit solenoid, its loose core and spring to act against it, and the shunt-circuit solenoid, its core, the rod $e$, a lever to carry the core and

rod, and a spring of sufficient strength connected with the said lever to overcome the magnetic force exerted by the shunt-circuit solenoid upon its core when the lamp is in circuit and the arc is abnormally small, and to be overcome by the said magnetic force when the arc is abnormally great, the force of the said spring being overcome by the spring acting upon the core of the main-circuit solenoid when the lamp is out of circuit, substantially as described.

3. In an electric lamp, an automatic safety or cut-out circuit containing a differential magnet, the coarse wire of which is in the main circuit and the fine wire in the shunt-circuit, an armature for the said magnet, and a terminal or back-stop, *n*, for the said armature, the said armature and back-stop forming the terminals of the cut out circuit, combined with a resistance-coil, the said automatic safety or cut-out circuit being operated by the differential action of the main and shunt circuits to cut out the lamp when the arc becomes abnormally great by reason of a failure of the carbons to feed, or a breaking of a carbon or other like cause, substantially as described.

4. In an electric lamp, two solenoids, one in the main and the other in the shunt circuit, combined with a differential magnet and its armature, arranged, when not attracted, to close a safety or cut-out circuit, a part of the wire of the differential magnet being in circuit with the main solenoid, and another part of the said wire being in circuit with the shunt-solenoid, thus enabling the safety-circuit to be put into operation when the arc is abnormally long, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GEORGE A. MAYO.

Witnesses:
G. W. GREGORY,
B. J. NOYES.