2 Sheets—Sheet 1.

F. VON HEFNER ALTENECK.

Electric Lamp.

No. 243,341. **Patented June 21, 1881.**

Fig. 1.

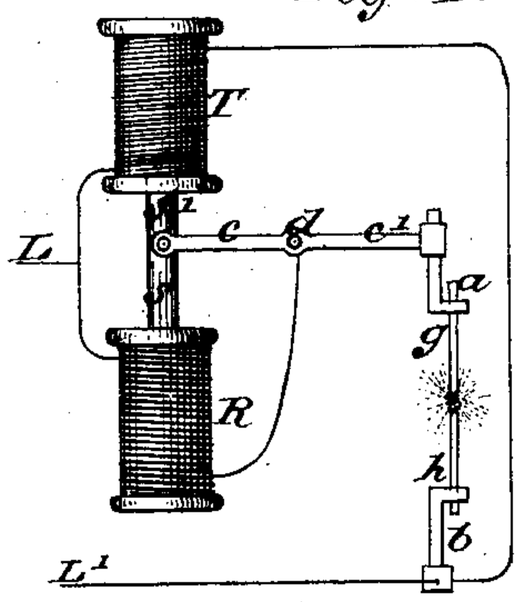


Fig. 2

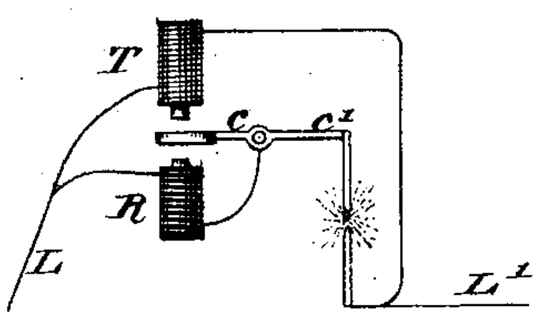


Fig. 3.

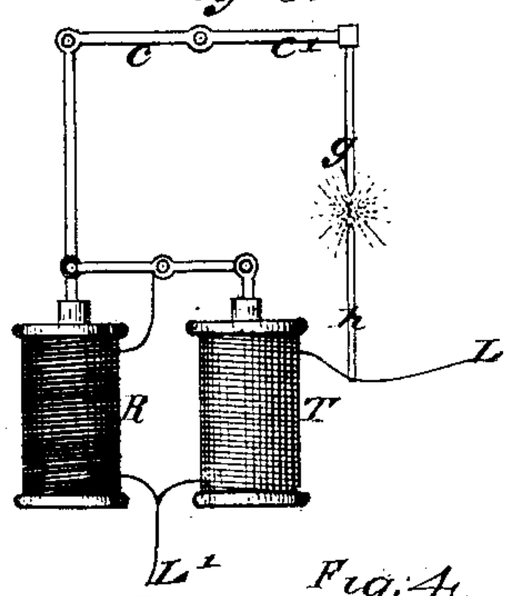


Fig. 4.

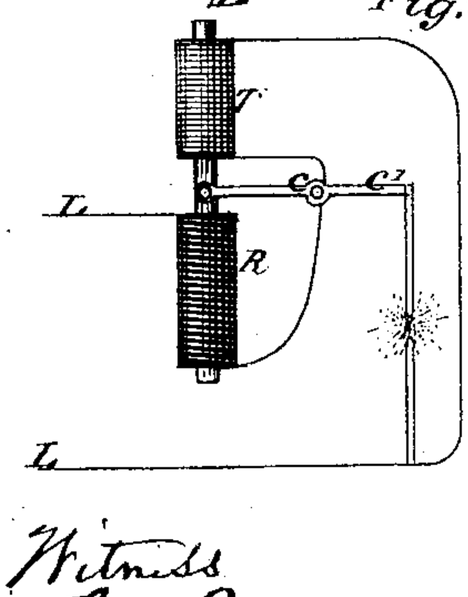


Fig. 7.

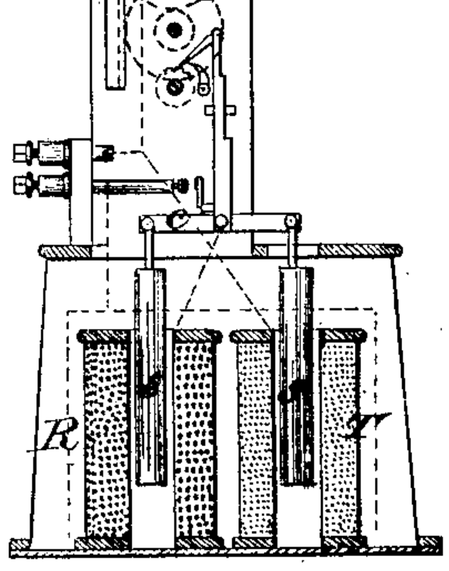
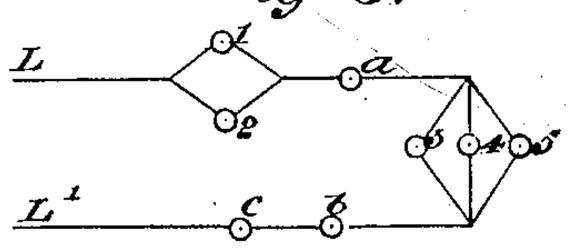


Fig. 5.



Witnesses
Leo Bacon
John D. Hyer.

von Hefner Alteneck by
Charles S. Whitman
attorney

2 Sheets—Sheet 2.

F. VON HEFNER ALTENECK.

Electric Lamp.

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Fig: 6.

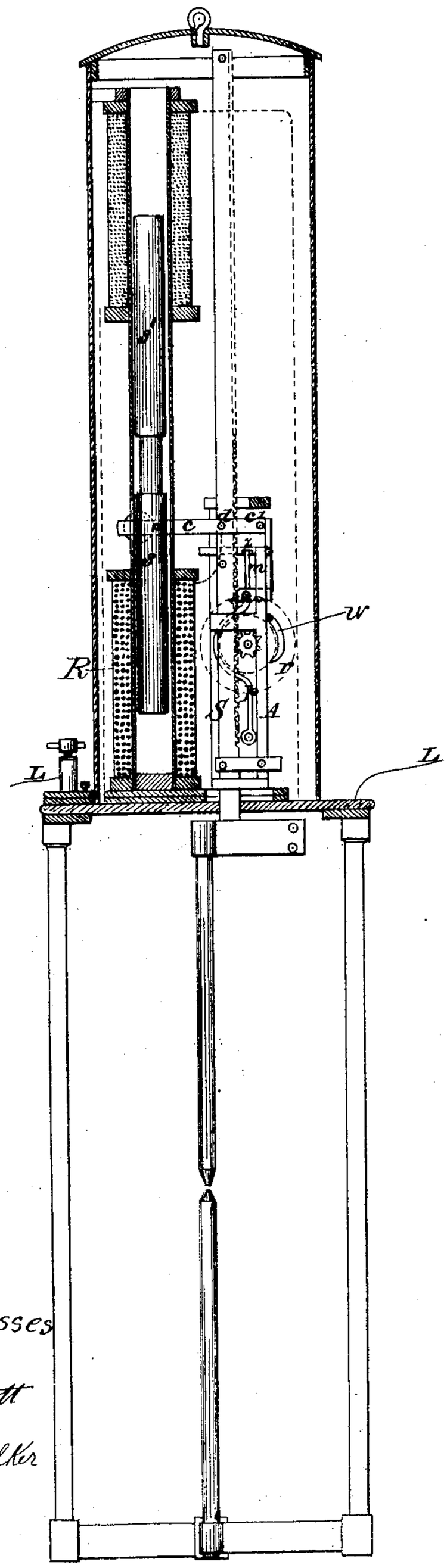
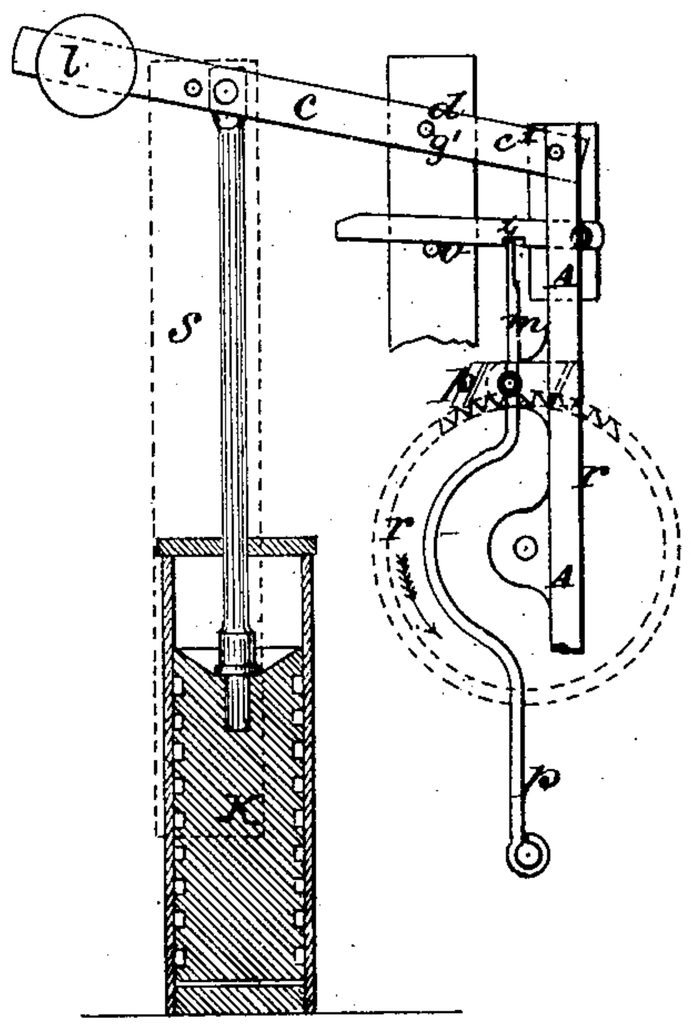


Fig: 8.



Witnesses

A. Scott

B. K. Walker

F. von Hefner Alteneck

by Charles S. Whitman

Attorney

UNITED STATES PATENT OFFICE.

FRIEDRICH VON HEFNER-ALTENECK, OF BERLIN, GERMANY, ASSIGNOR TO CHARLES WILLIAM SIEMENS, OF WESTMINSTER, ENGLAND.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 243,341, dated June 21, 1881.

Application filed September 16, 1879. Patented in England December 4, 1878.

To all whom it may concern:

Be it known that I, FRIEDRICH VON HEFNER-ALTENECK, of Berlin, in the German Empire, have invented an Improvement in Electric Lamps; and I do hereby declare that the following description, taken in connection with the accompanying drawings, hereinafter referred to, forms a full and exact specification of the same, wherein I have set forth the nature and principles of my said improvement, by which my invention may be distinguished from others of a similar class, together with such parts as I claim and desire to secure by Letters Patent—that is to say:

This invention relates mainly to a method of regulating electric lamps by the counteracting forces of two coils of different resistance, through which the electric current is made to pass, and which actuate the carbon-poles in such a manner that when by a too near approach of the carbon-poles the current passing through the lamp becomes too strong the coil of least resistance causes the carbons to separate, while when by a too great separation of the carbons the current is reduced the coil of greater resistance is brought into action, so as to bring the carbons together again. For this purpose the electric conductor, in some part of its course to or from or in the lamp, divides into two branches, the one leading through the coil of a solenoid or electro-magnet of high resistance directly back to the external circuit, and the other through a coil of low resistance indirectly back to the external circuit through the carbons and arc of the lamp. The cores of the two solenoids or the armatures of the two electro-magnets are connected to either or both of the carbon-holders in such a manner that when the one solenoid or electro-magnet—namely, that having the coil of high resistance—is excited the movement of its core or armature causes the carbons to approach toward each other, and when the other solenoid or electro-magnet—namely, that having the coil of low resistance—is excited the carbons are caused to recede from one another, and thus when both are excited the carbons are caused to take a position dependent on the relation of the two counteracting forces operating upon them, which position, by suitable adjustments, can be determined, so as to produce the desired illuminating voltaic arc. In the working of the lamp, should the carbons approach too nearly to each other, then, the resistance of the arc between them being diminished, less of the electricity passes through the coil of high resistance and more passes through the coil of low resistance, exciting more vigorously the solenoid or electro-magnet that causes the separation of the carbons. If, on the other hand, the carbons should be too far apart, the resistance of the voltaic arc being greater, less electricity passes through the coil of low resistance and more passes through the coil of high resistance, exciting more vigorously the solenoid or electro-magnet that causes the approach of the carbons. As, notwithstanding considerable variations in the quantity of electricity supplied to the circuit or drawn from it, the relation between the forces developed by the two coils remains practically constant, this method of regulation secures great uniformity in the illuminating power of each lamp, and allows of the introduction of a variable number of lamps into one circuit without rendering each of these lamps subject to the fluctuations of others of the set. Moreover, the lamps thus introduced into the circuit may be made of varied illuminating power by connecting them to the circuit either directly in series or in parallel branches.

In lamps regulated as above described the feed of the carbons as they are consumed may be effected in the manner hereinafter set forth, or in any other known manner. The two coils may be wound on separate bobbins, each, when wound as a solenoid, having its own movable core, or, when wound on a stationary core forming an electro-magnet, having its own armature. The whole current may be passed through the coil of low resistance, the conductor therefrom dividing into two branches, the one through the carbons and arc and the other through the highly-resisting coil.

In the drawings, Figure 1 shows diagrammatically one arrangement of electric lamp with regulating apparatus according to this invention.

g and *h* indicate the carbons, held respectively in the sockets *a* and *b*, and provided with

any known means of feeding as they are consumed. The one socket, *a*, is attached to one arm, *c'*, of a lever pivoted at *d*, and having its opposite arm, *c*, connected to a piece of non-magnetic material uniting a pair of iron cores, *s s'*. The core *s* is free to play up and down within a solenoid, R, the coil of which is of large wire, offering small resistance, and forms part of the lamp-circuit. The core *s'* is free to play up and down within a solenoid, T, having a coil of smaller wire, offering greater resistance than the coil of R. The coil of T is in a circuit external to the lamp—that is to say, joining the conductors L L' without including the carbons. When the solenoid R, being excited, draws in its core *s* the points of the carbons are separated. When, on the other hand, the solenoid T draws in its core *s'* the carbons are caused to approach each other. As the relative force of the two solenoids depends upon the quantity of electricity passing respectively through these coils, and as this depends upon the relative resistance of their respective circuits, the circuit of the one consisting of the coil T and its connections to the main circuit, and the circuit of the other consisting of the coil R, the carbons, and the arc between them, that portion of the latter which consists of the arc being dependent on the distance of the carbons apart, this distance will become adjusted automatically by the action of the two solenoids, so as practically to maintain constant action of the lamp. If, for example, the carbons should be too near, a larger proportion of the electric current passing through the coil R than through the coil T will cause superior attraction of the core *s*, separating the carbons, and thereby increasing the resistance of the arc between them, and so lessening the quantity of electric current that passes through them. If, on the other hand, the carbons should be too far apart, then the coil R, being less excited than the coil T, will exert less attractive force on its core *s*, permitting the other core, *s'*, to be drawn into its coil, and thus causing an approach of the carbons, which will lessen the resistance of the arc between them, and so permit the passage of a larger proportion of the current through them. Thus, the regulation of the lamp being dependent only on the resistance of its voltaic arc and independent of the strength of current, the action of any one lamp in a circuit will not affect that of other lamps in the same circuit, and consequently a number of such lamps can by means of this invention be effectually worked in one and the same circuit.

In like manner as above described, instead of employing two solenoid coils with cores attracted into them in opposite directions, two electro-magnets acting in opposite directions on an armature may be arranged as shown diagrammatically in Fig. 2.

R and T are two electro-magnets. The coil of R, of small resistance, is in the lamp-circuit. The coil of T, of greater resistance, is in a circuit external to the lamp. Both electro-magnets act on an armature, *c*, at one end of a lever, the other end of which carries one of the carbon-holders. The distance of the carbon points will obviously be automatically adjusted as above described with reference to the arrangement indicated in Fig. 1.

The arrangement of the two solenoids or electro-magnets and of their mechanical connections to the carbons may be varied in many ways—as, for example, in the manner shown diagrammatically in Fig. 3, in which the two solenoids R and T are arranged side by side, with their cores acting at opposite ends of a lever.

Instead of dividing the conductor into two branches before reaching the two coils, it may be branched after passing the coil of low resistance, as indicated in Fig. 4. Here the arrangement of the two solenoids R and T, with their cores connected to the carbon-lever, is similar to that described with reference to Fig. 1; but the whole current passes through the carbons and arc, and a portion branches through the coil T of the higher resistance. When lamps are arranged as above described, with two solenoids or electro-magnets having coils of different resistance operating in opposite directions on cores or armatures connected to the carbons, so as to effect their automatic adjustment, a number of such lamps can be placed in one circuit and can be worked with various degrees of power, according to the manner in which they are connected thereto, whether in series or in parallel branches, as illustrated diagrammatically at Fig. 5. In this diagram the lamps *a b c* would receive the full power of the current, the lamps 1 and 2 would receive each about one-half, and the lamps 3, 4, and 5 would receive each about one-third of the full power.

Fig. 6 is a vertical section of a lamp with a pair of regulating-solenoids, operating as described with reference to Fig. 1, in combination with an arrangement for feeding the upper carbon, to be presently described. In this construction, R is the one solenoid, having its coil of low resistance in the lamp-circuit surrounding the core *s*, which is connected to the lever-arm *c*. The other solenoid, T, having its coil of higher resistance in a circuit external to the lamp, surrounds the core *s'*, which is connected by a piece of non-magnetic material to the core *s*. The lever *c* is pivoted at *d* on the fixed framing of the lamp, and carries on its arm *c'* the slide and rack for the upper carbon by means of the disengaging-gear, to be presently described, which permits the carbon-slide to descend a little to allow for waste, when the automatic adjustment effected by the action of the solenoids brings the disengaging-gear down to a fixed stop.

Fig. 7 shows a mode of applying to a known construction of lamp the arrangement of the two solenoids R and T, having their cores *s* and *s'* connected to opposite arms of a lever,

as illustrated in Fig. 3, the lever *c*, worked by these cores, being in the lamp shown in Fig. 7 made to operate on the gearing connected to the carbon-slides.

The arrangement for feeding the upper carbon of the lamp shown at Fig. 6 is as follows: A stem, A, is pivoted to one end of a lever, *c*, turning on a fixed fulcrum at *g'*, and pivoted at its other end to the core *s* of the electro-magnet. To the stem A are pivoted, first, a pendulum, *p*, with escapement-teeth, and, secondly, an escapement-wheel, *r*. The carbon-slide S is toothed at its edge, as a rack, engaging with a pinion on the axis of the wheel *r*, which serves to connect it with the stem in the manner shown in the enlarged view at Fig. 8, the stem A being carried by the lever *cc'*. The wheel *r* has teeth, working the escapement of a small pendulum, *p*. So long as the stem A is above its lowest position this pendulum is prevented from moving by its tail *m* being caught in the notch of a lever-arm, *z*, which is pivoted on A. When, however, owing to the consumption of the carbons, the stem A has descended to its lowest position, then the arm *z*, catching on a fixed stud, *v*, is raised so as to clear the tail *m* out of the notch, leaving the pendulum free to swing. The slide S then descends, causing the wheel *r* to turn in the direction of the arrow, swinging the pendulum, which controls its movement, and this continues till the stem A, being again raised by the action of the core *s* under the influence of an increased current, the pendulum-tail *m* is again caught in the notch of *z*, and the wheel *r* is consequently stopped, thus arresting the descent of the carbon-slide. The wheel *r* is provided with a pawl, *w*, to prevent it from turning backward. The movements of the cores *s s'* may be damped by means of a plunger, K, working in a cylinder.

Having thus described the nature of my invention and in what manner the same is to be performed, I claim—

1. In an electric lamp, in combination with the carbon-holders, two solenoids or electro-magnets, one of which has a coil of low resistance, forming a part of the lamp-circuit, and the other has a coil of higher resistance, forming a part of a by-pass circuit, by the differential action of which the carbons are adjusted.

2. The combination of the regulating-stem A, carrying the carbon-slide of an electric lamp, with the levers *c c'*, cores *s* and *s'*, and solenoid-coils R and T, substantially as herein described.

3. The combination of the regulating-stem A with the carbon-slide S, having rack-teeth gearing with a pinion on the axis of the escapement-wheel *r*, the pendulum *p*, having a tail, *m*, engaging with a notch in the arm *z*, and the fixed stud *v*, constructed and operating substantially as herein described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 26th day of July, 1879.

FRD. VON HEFNER-ALTENECK.

Witnesses:
BERTHOLD ROI,
EDWARD P. MACLEAN.