No. 710,068. Patented Sept. 30, 1902.

E. O. LUNDIN & F. A. GILBERT.

W. A. PAINE & E. W. BURDETT, Administrators of F. A. GILBERT, Dec'd.

METHOD OF MAINTAINING UNIFORM RESISTANCE IN ARC LAMP CIRCUITS.

(Application filed Apr. 30, 1902.)

(No Model.)

Fig. 2.

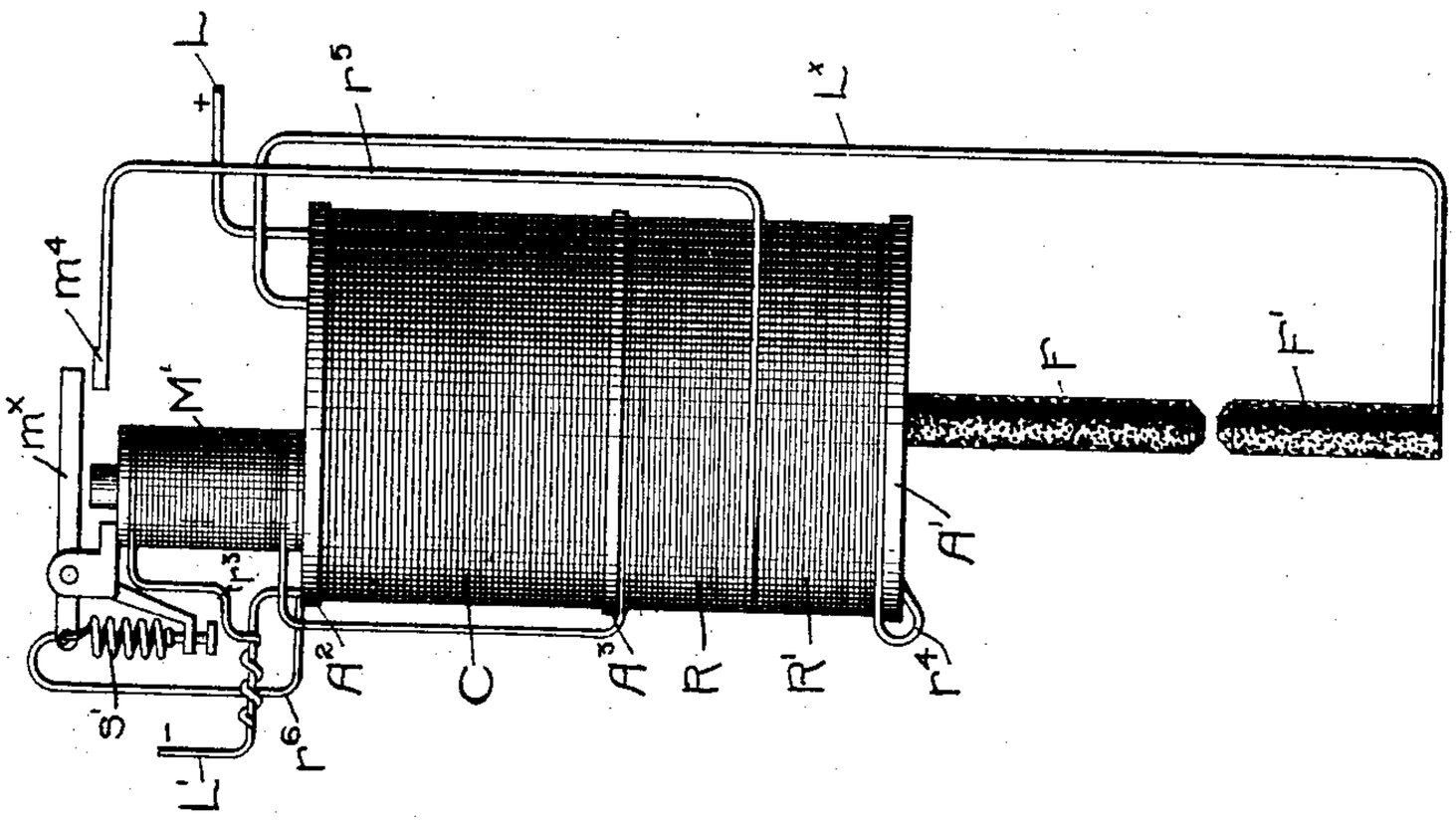
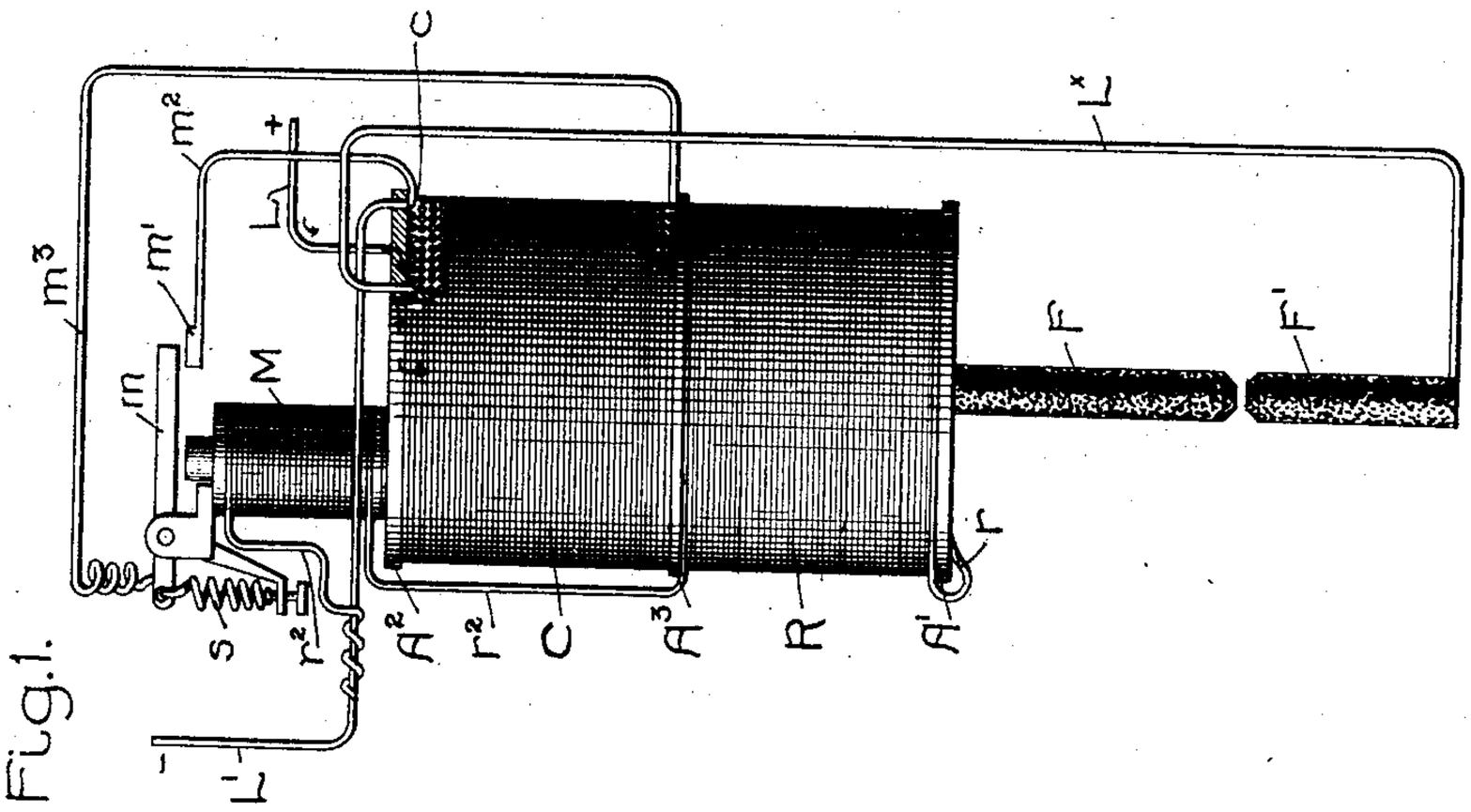


Fig. 1.



WITNESSES.

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UNITED STATES PATENT OFFICE.

EMIL O. LUNDIN, OF BOSTON, MASSACHUSETTS, AND WILLIAM A. PAINE AND EVERETT W. BURDETT ADMINISTRATORS OF FREDERICK A. GILBERT, DECEASED.

METHOD OF MAINTAINING UNIFORM RESISTANCE IN ARC-LAMP CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 710,068, dated September 30, 1902.

Original application filed December 17, 1897, Serial No. 662,284. Divided and this application filed April 30, 1902. Serial No. 105,314. (No model.)

To all whom it may concern:

Be it known that we, EMIL O. LUNDIN, of Boston, county of Suffolk, and FREDERICK A. GILBERT, deceased, late of Brookline, county of Norfolk, State of Massachusetts, invented during the lifetime of said GILBERT new and useful Improvements in Methods of Maintaining Uniform Resistance in Arc-Lamp Circuits, (Case No. 2,761,) of which the following is a specification.

This invention relates to a method of maintaining a substantially uniform resistance in an electric circuit which owing to some cause is liable to have its resistance capacity changed or varied; and it is particularly adapted for use in connection with the regulation of electric-arc lamps. Normally the feed-controlling circuit has a certain resistance, and when the current is turned on the carbons will be separated to form the arc; but after the lamp has been burning for some time the resistance of the feed-controlling circuit will increase by the rise in temperature of the lamp. Ordinarily the power of the feed-controlling circuit will be so reduced that the carbons will not be brought together to reduce the length of the arc until the voltage is increased very much. To overcome this objectionable feature, the present practice is to make the normal resistance of the feed-controlling circuit less than that required to attain the proper length of arc, so that the proper resistance will not be reached until the lamp has become heated, and prior to such time the arc is too short, resulting in a poor light.

In another application, Serial No. 659,391, filed November 22, 1897, by the same inventors was disclosed a method for maintaining the resistance substantially uniform by varying the effective extent of the resistance medium inversely to and to compensate for the change in the resistance capacity per unit of such medium due to an extraneous cause, such as heating, and means were provided for carrying out the invention when applied to an electric-arc lamp by or through means the operation of which was due to a change in temperature of the lamp. In the present invention the same result is effected in another manner by utilizing the change of voltage in the lamp after it has been burning to either weaken the magnetic effect of the series winding or to reduce the effective resistance of the shunt-winding.

Figure 1 in elevation represents a sufficient portion of an arc-lamp to be understood with one embodiment of the present invention applied thereto, and Fig. 2 is a similar view of another form of apparatus for carrying out the invention.

Referring first to Fig. 1, a suitable metal body is provided with a base A' and top A^2, the upper carbon F passing through the body, top, and base, substantially as shown in the patent to the same inventors, No. 603,630, dated May 10, 1898. The current enters the lamp by the line-wire L, electrically connected with the metal body, and passes thence to the upper carbon F by suitable contacts, (not shown,) then from the lower carbon F' by wire $L^\times$ to one of the series coils C, through the latter, and back to line at L'. The series coil C is wound upon a suitable core at the upper portion of the lamp-body between the top A^2 and an insulating-plate A^3, intermediate the top and base, the wire $L^\times$ being connected with the inner end of the coil. One or more of the layers of the coil—the outmost *c*, as herein shown—is connected at its extremity with the line-wire L' and also with a fixed contact m' by a wire m^2. An electromagnet M is shown as mounted on the top A^2, its armature m being electrically connected by wire m^3 with the beginning of the layer or winding *c*, said armature being normally held by a suitable spring *s*, as herein shown, out of contact with the terminal m', the circuit $c\ m^2\ m'$, armature m, and wire m^3 being thus normally open. The shunt-coil R is located between the base A' and the intermediate insulation A^3 in shunt with the arc, one end of the coil being connected at r with the lamp-body and the other end with the line-wire L' by wire r^2; but said shunt-coil includes the coils of the magnet M, as clearly shown. Now when the lamp is cold the current in the shunt-coil R will be insuf-

ficent to energize the magnet M, and the current passing through the entire series coil C will lift the carbon F and form the arc with nearly full separation of the carbons. After the lamp has been burning the rise in temperature will increase the resistance of the shunt-coil; but the increase in voltage due to burning away of the carbon is more rapid and more current will be sent through the shunt-coil, energizing the magnet M, and the armature m will connect with the terminal m', short-circuiting the part of the series coil C between the wires m^2 m^3. This weakens the magnetic effect of the series coil, which is equivalent in its effect to increasing the strength of the shunt-coil, so that the carbon will be drawn down by the action of the shunt-winding to its proper position, shortening the arc to its proper length. After such action the resistance will be sufficient to properly control the feed of the carbon. Just as soon as the auxiliary magnet M is energized still more current will be forced through the shunt-winding, and the armature will be the more firmly held upon the contact-terminal m'. In this construction it is true that the resistance of the shunt-winding increases, due to heating of the lamp, and the voltage increases more rapidly; yet the actual effectiveness of the shunt-winding to pull the carbon down and maintain the proper length of arc would be too slight after the lamp has been running were it not for the cutting out or short-circuiting of a portion of the series winding to compensate for this decrease in the effectiveness of the shunt-winding. The increase in voltage is thus made effective to maintain uniformity in the length of the arc notwithstanding a variation in resistance of the feed-controlling circuit.

In Fig. 2 the device operates to maintain a substantially uniform arc; but it is accomplished in a different manner. As in Fig. 1, the series coil C is wound on a core between the top A^2 of the lamp-body and the intermediate insulation, the line-wire L being electrically connected with the body, while the current passes from lower carbon F' by wire $L^\times$ to one end of the series winding C, the other end of the latter being connected with the line at L'. The shunt-coil is wound between the base and the partition A^3, and while practically a single coil it may be made in two parts R R', the former of copper wire and the latter of German-silver wire, the part R' being cut out or short-circuited, as will be described, after the lamp has been burning for some time. An auxiliary electromagnet M' is shown mounted on the top in circuit with the part R of the shunt-winding, the said winding being connected at r^3 with the line-wire L' and at r^4 with the lamp-body. The adjacent ends of the two parts R R' of the shunt-winding are connected by a wire r^5 with a fixed contact-terminal m^4, the armature $m^\times$ of the magnet M' being normally held away from the contact by a spring s', said armature being electrically connected by a wire r^6 with the lamp-body.

The total resistance of the shunt-winding when the lamp is cool is about what it should be for substantially the proper length of arc in starting the lamp; but insufficient current will pass through the shunt-winding to energize the magnet M' and operate its armature. After the lamp has been burning for a time, however, the carbon will have burned away, increasing the length of the arc, and the voltage at the arc will increase, sending more current through the shunt-winding. This increase in the voltage is more rapid than the increased resistance of the shunt-winding due to heating of the lamp, and at a certain point the current passing will be sufficient to energize the magnet M', closing the auxiliary circuit at m^4, and thereby cutting out the portion R' of the shunt-winding, such portion cut out being calculated so that the immediately-following increase of current in the remaining portion of the shunt-winding will have sufficient power to draw the carbon down and reduce the arc to the proper length. Thus in each case the length of the arc is controlled by or through the increase of voltage, and in both cases the device is regulated as to the time of its operation by means of the spring controlling the armature of the auxiliary magnet, so that as the spring is made stronger or weaker the increase of voltage will be correspondingly greater or less before the change in one or the other of the coils is effected.

In the construction shown in Fig. 1 the effectiveness of the series winding is reduced by reducing the effective extent of the coil-while in the construction shown in Fig. 2 the same final result is attained, but by decreasing the resistance of the shunt-winding through a reduction in the effective extent of the resistance medium.

The present case is a division of the application of the same inventors, Serial No. 662,284, filed December 17, 1897.

What is claimed as new is—

1. The method of regulating electric-arc lamps having series and shunt regulating-coils, which consists in varying the regulating power of said coils when the heat after starting the lamp, inversely to, and to compensate for, change of voltage at the arc accompanying such heating.

2. The method of regulating arc-lamps having series and shunt arc-regulating coils, which consists in automatically cutting out a part of one of said coils when it heats after starting the lamp, to compensate for the change of voltage at the arc accompanying such heating.

3. The method of regulating electric-arc lamps having series and shunt regulating-coils, which consists in increasing the power of the shunt-coil when it heats after starting the lamp, to compensate for the increased

voltage at the arc accompanying the rise of coil resistance due to such heating, whereby the shunt-winding is rendered uniform in the starting and running condition of the lamp, and the length of arc is also maintained uniform.

4. The method of regulating electric-arc lamps and maintaining uniform arc length, which consists in automatically controlling the operation of the feed-regulating circuit when it heats after starting the lamp, by, and to compensate for, variation of voltage at the arc accompanying the change of coil resistance due to such heating.

5. The method of regulating electric-arc lamps, which consists in automatically increasing the effective power of the feed-controlling circuit to compensate for loss of power due to heating of the circuit when the voltage at the arc rises as a consequence of such heating to a determinate degree.

In witness whereof we have hereunto set our hands this 25th day of March, 1902.

EMIL O. LUNDIN.
WILLIAM A. PAINE,
EVERETT W. BURDETT,
Administrators of the estate of Frederick A. Gilbert, deceased.

Witnesses to E. O. L.:
JOHN GORDON,
M. JOHNSTON.
Witnesses to W. A. P.:
R. GEO. RESTALL,
JOHN GORDON.
Witnesses to E. W. B.:
JOHN GORDON,
CHARLES A. SNOW.

Correction in Letters Patent No. 710,068.

It is hereby certified that in Letters Patent No. 710,068, granted September 30, 1902, upon the application of Emil O. Lundin, of Boston, Massachusetts, and William A. Paine and Everett W. Burdett, administrators of Frederick A. Gilbert, deceased, for an improvement in "Methods of Maintaining Uniform Resistance in Arc-Lamp Circuits," an error appears in the printed specification requiring correction, as follows: In line 119, page 2, the word "the" should read *they;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 31st day of March, A. D., 1903.

[SEAL.]

F. I. ALLEN,

Commissioner of Patents.