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

APPARATUS FOR MAINTAINING UNIFORM RESISTANCE IN ELECTRIC CIRCUITS.

(Application filed Dec. 17, 1897. Renewed Feb. 3, 1899.)

(No Model.)

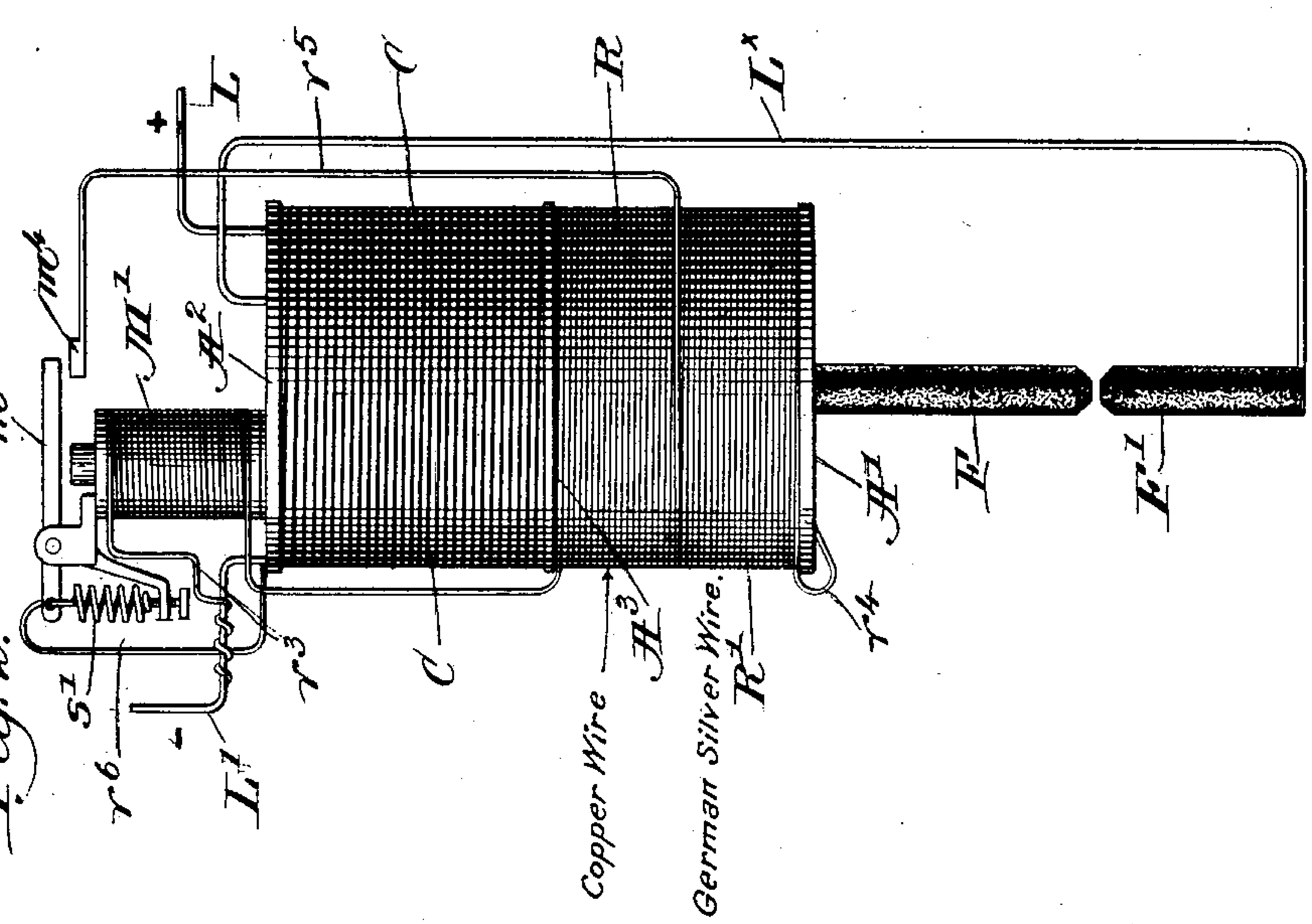

Fig. 2.

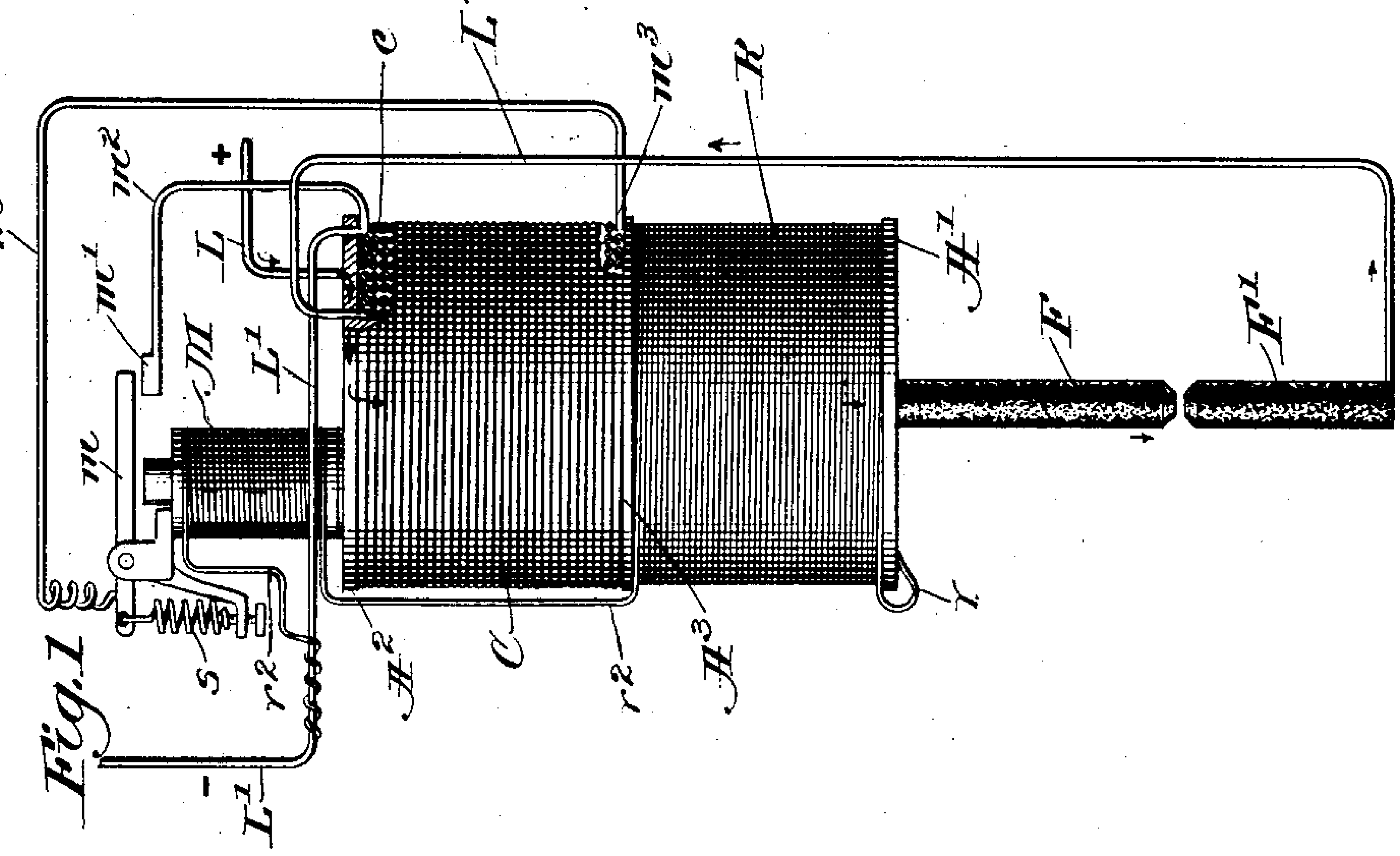

Fig. 1

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR MAINTAINING UNIFORM RESISTANCE IN ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 710,052, dated September 30, 1902.

Application filed December 17, 1897. Renewed February 3, 1899. Serial No. 704,434. (No model.)

To all whom it may concern:

Be it known that we, FREDERICK A. GILBERT, of Brookline, county of Norfolk, and EMIL O. LUNDIN, of Beachmont, county of Suffolk, State of Massachusetts, have invented an Improvement in Apparatus for Maintaining Uniform Resistance in Arc-Lamp Circuits, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to apparatus for 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 us we 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 we provided means for carrying out our 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 our present invention we effect the same result 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. The mode of operation by which this result is effected is, however, not claimed in the present application, but is reserved to a divisional application copending herewith, the present application being restricted to claims for the apparatus.

Figure 1 in elevation represents a sufficient portion of an arc-lamp frame to be understood with one embodiment of our invention applied thereto, and Fig. 2 is a similar view of another form of apparatus for carrying out our 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 another application, Serial No. 643,133, filed by us July 1, 1897.

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 end of the series coil 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 outermost, *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 insufficient 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.

Having described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. An electric-arc lamp provided with series and shunt regulating coils, and a controlling-magnet in shunt to the arc for cutting out part of one of said coils after a determinate rise of temperature due to starting the lamp, to compensate for change of arc length due to such rise of temperature.

2. In an electric-arc lamp, series and shunt wound carbon-feed-controlling coils, and means, including an electromagnet in circuit with the shunt-winding and responsive to in-

crease of voltage at the arc, to increase the effectiveness of the shunt-winding.

3. In an electric-arc lamp, series and shunt wound carbon-feed-controlling coils, means, including an electromagnet in circuit with the shunt-winding and responsive to increase of voltage at the arc, to increase the effectiveness of the shunt-winding, and a manually-operated regulating device to determine the time of operation of the electromagnet.

4. In an electric-arc lamp, series and shunt wound carbon-feed-controlling coils, a shunt-circuit including a portion of one of said coils, and a controlling-magnet for said circuit, in circuit with the shunt-winding, to operate the shunt-circuit and cut out the portion of the coil included therein upon increase of voltage at the arc.

5. In an electric-arc lamp, series and shunt wound coils to control the carbon, a controlling-magnet in circuit with the shunt-winding, its armature, means to control its time of operation, said armature forming one terminal of a shunt-circuit including a portion of one of said coils, and a fixed contact forming the other terminal, whereby increase of current in the shunt-winding will energize the controlling-magnet to close the shunt circuit, and thereby cut out the included coil portion.

6. In an electric-arc lamp, the combination of two magnets operating on a common feed-controlling mechanism, and means controlled by rise of temperature of the magnet-coils after starting the lamp to compensate for change of arc length due to such rise of temperature.

7. In an electric-arc lamp, the combination of two magnets differentially mounted in relation to a common feed-controlling mechanism, and an electromagnet controlled by change of voltage in the arc to vary the strength of one magnet after starting the lamp to compensate for change of arc length due to rise of temperature.

8. An electric-arc lamp provided with regulating devices for the arc traversed by the current, and means for increasing the effectiveness of said devices after heating under the transit of current, to maintain uniform the arc length.

9. An arc-lamp provided with a regulating-coil and a cut-out controlled by increase of temperature after starting of the lamp, to compensate for change of resistance of the regulating-coil due to heating.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

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EMIL O. LUNDIN.

Witnesses:
CHARLES A. SNOW,
EVERETT W. BURDETT.