

1,374,404.

Patented Apr. 12, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

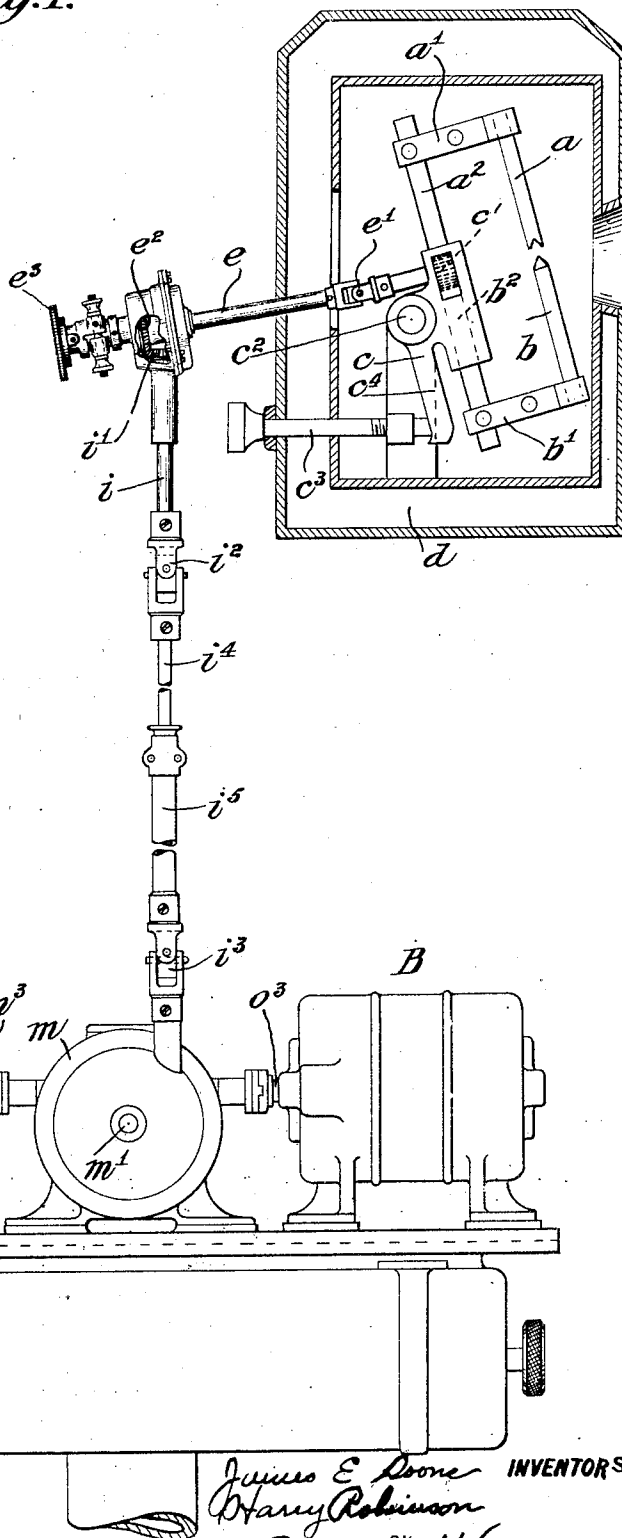
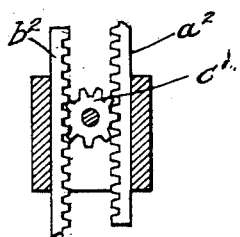


Fig. 5.



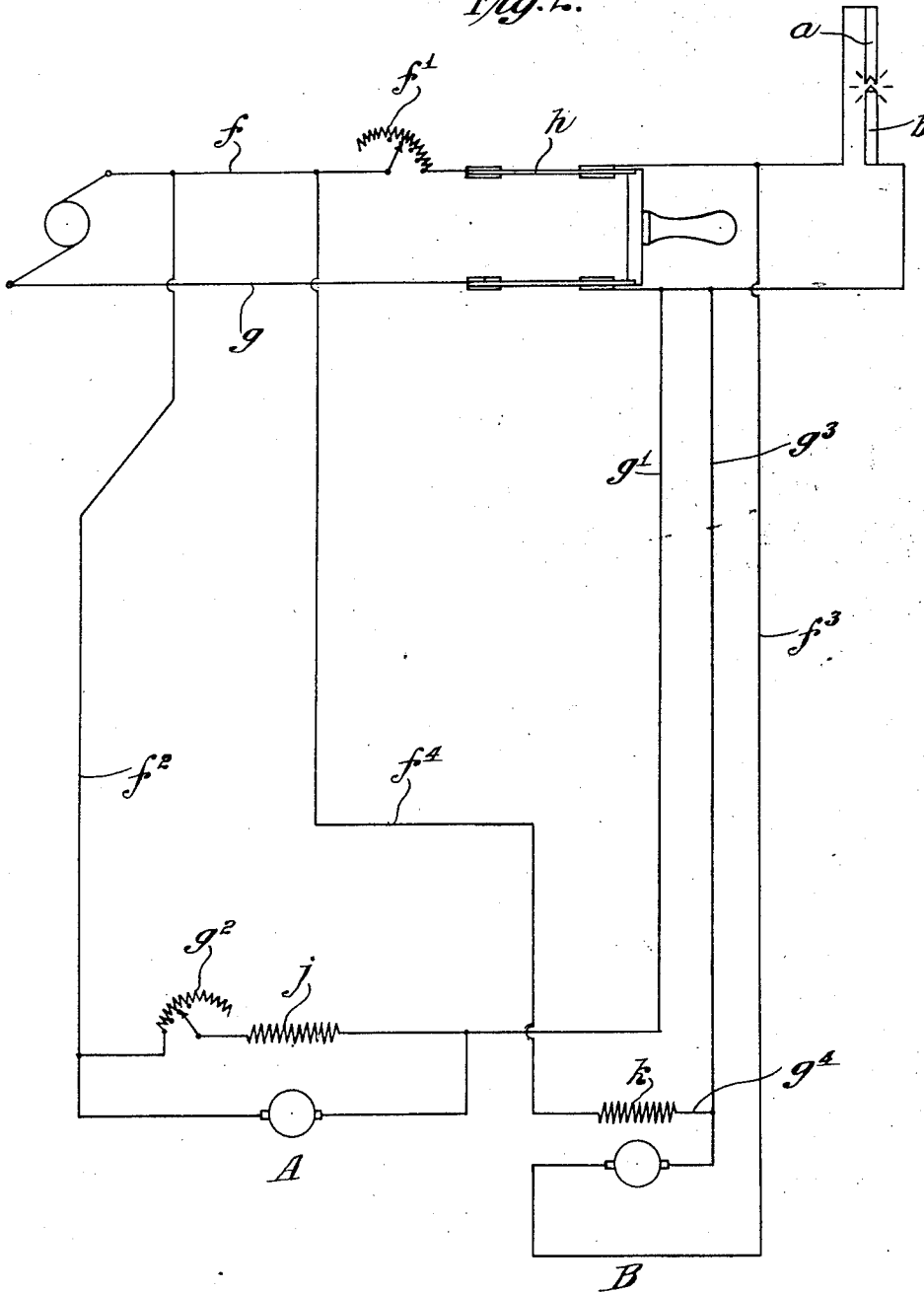
WITNESSES
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Patented Apr. 12, 1921.
 3 SHEETS—SHEET 2.

Fig. 2.



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AUTOMATIC ARC REGULATOR.

APPLICATION FILED NOV. 15, 1919.

1,374,404.

Patented Apr. 12, 1921.

3 SHEETS—SHEET 3.

Fig. 4.

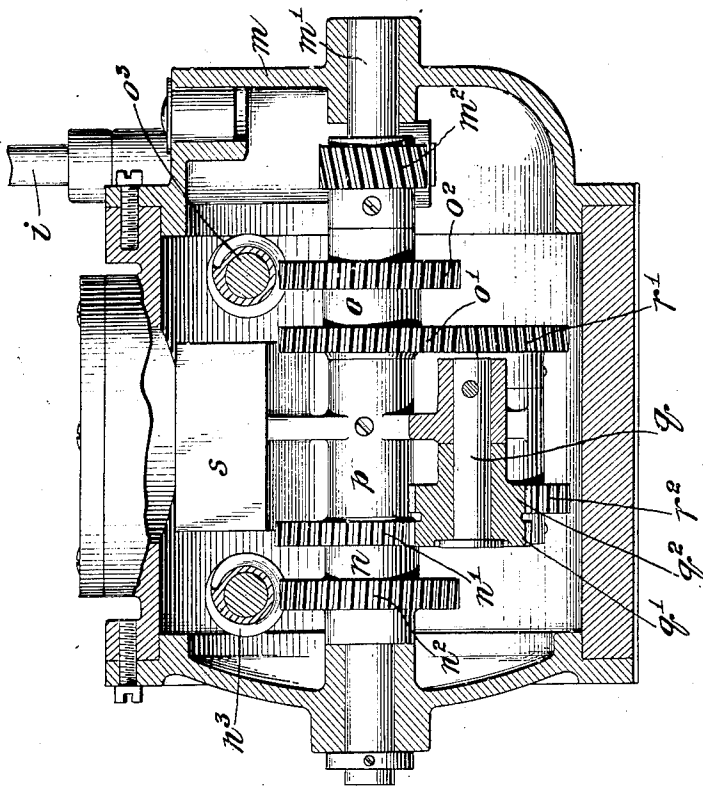
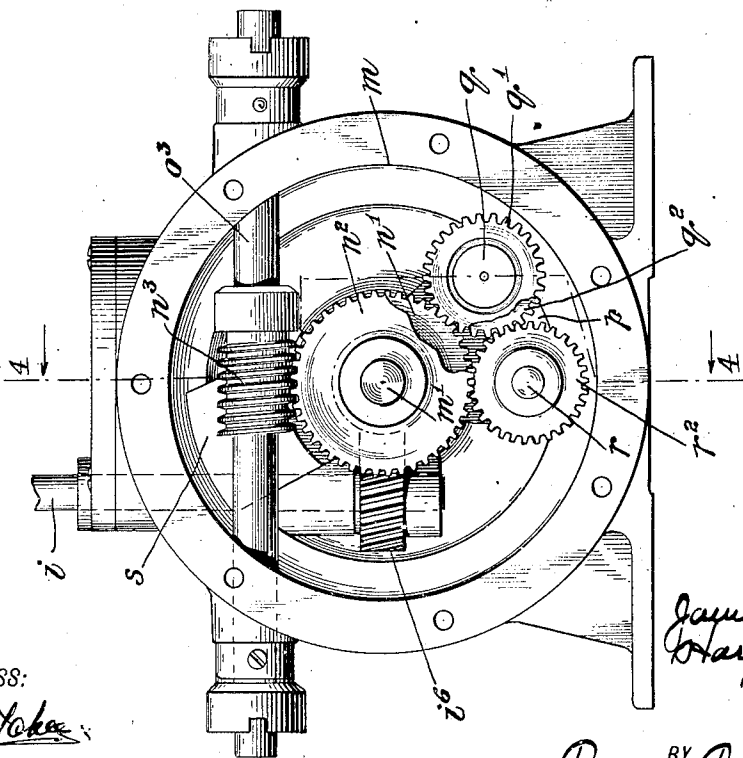


Fig. 5.



WITNESS:

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UNITED STATES PATENT OFFICE.

JAMES E. SOONS, OF NEW YORK, AND HARRY ROBINSON, OF BROOKLYN, NEW YORK,
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AUTOMATIC ARC-REGULATOR.

1,374,404.

Specification of Letters Patent.

Patented Apr. 12, 1921.

Application filed November 15, 1919. Serial No. 338,159.

To all whom it may concern:

Be it known that we, JAMES E. SOONS and HARRY ROBINSON, respectively a subject of the King of the United Kingdom of Great Britain and Ireland and a citizen of the United States, residing, respectively, at the borough of Bronx, city of New York, county of Bronx, and State of New York, and at the borough of Brooklyn, city of New York, county of Kings, and State of New York, have invented certain new and useful Improvements in Automatic Arc-Regulators, of which the following is a specification, reference being had therein to the accompanying drawings, which form a part thereof.

Our invention relates to automatic arc regulators and more particularly to a mechanism which will maintain a substantially uniform length of the arc and constant intensity of the light.

In arc lighting it has been the common practice to provide means actuated as a result of variance in the potential of the circuit to the electrodes, or increased resistance at the arc, which will automatically feed one or both of the electrodes toward each other so as to intermittently restore the gap between the electrodes to that securing the desired length of arc.

This type of regulating mechanism has proven unsatisfactory in connection with high amperage arc lights used in cinematographic projectors and similar mechanisms wherein constant intensity of the light from the lamp is essential. Owing to this condition it has been a common practice to provide manually operative means for controlling the arc, the skill of the operator being relied upon to maintain the desired length of arc.

In a regulator made in accordance with our invention, the arrangement of parts and the electrical conditions are such that the electrodes will be gradually advanced toward each other with the burning of the carbons, the rate of advance being modified or controlled through the resistance at the arc in a manner to prevent any such variation in the length of the arc gap as will occasion any noticeable change in the intensity of the light. The feed of the carbons

instead of being solely intermittent will be constant and proportioned more or less to their rate of consumption, any loss of uniformity between the rate of feed and rate of consumption being compensated for by an automatic change in the rate of feed as determined by a change of potential in the lamp circuit at the arc. The feed will be accelerated or reduced as conditions demand, but the mechanism is so sensitive that such changes will occur with so slight a variation in the resistance at the arc, that there will be no sudden changes in the light effects.

In addition to the automatic regulation of the arc gap, a regulator made in accordance with our invention may be set to form an arc of any desired length, it being possible to reset the mechanism to change the length of arc while the lamp is burning, the carbons instantly coming to the position necessary for the desired length of arc, and being maintained in this relation.

When starting the lamp, our regulator will automatically bring the carbons into contact to establish the circuit therethrough, and immediately that the circuit is closed, it will automatically separate said carbons to strike the arc, and space the carbons to secure the desired length of the arc.

An essential characteristic of our invention is the employment of two electric motors coupled to a differential transmission mechanism adapted to actuate the electrodes, one of said motors being set to run at constant speed, and the other at a different speed determined by the potential of the current to the arc, said other motor being responsive to variations of this potential due to variable resistance at the arc as the result of the burning of the carbon or other electrodes. The normal difference in the speed of said motors, modified by the transmission mechanism, is such as to impart to the carbons a feeding movement approximating that required to maintain a constant length of the arc, but mechanical difficulties, and irregularities in the consumption of the carbons, make it impossible to exactly synchronize the regulator mechanism with the carbon consumption, so that variances in the resistance at the arc is depended upon to correct an absence of such synchronism.

The invention consists primarily in an automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a motor operative upon said transmission mechanism to impart thereto a normal tendency to separate the electrodes, means whereby continuous constant power is developed in said motor, and a motor having a different speed than first named motor operative upon said transmission mechanism to cause the electrodes to approach each other and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed, and in such other novel features of construction and combination of parts as are herein-after set forth and described, and more particularly pointed out in the claims hereto appended.

Referring to the drawings:—

Figure 1 is a side elevation of a regulator made in accordance with our invention, the lamp house being shown in section;

Fig. 2 is a diagram showing one system of wiring;

Fig. 3 is an end view of the transmission mechanism with the end plate removed;

Fig. 4 is a section on the line 4—4 of Fig. 3; and

Fig. 5 is a detail view of a conventional form of the means by which relative movement may be imparted to the carbon carrier.

Like letters refer to like parts throughout the several views.

In the embodiment of our invention shown in the drawings, we have illustrated it in connection with a constant potential lamp utilizing a 110 volt D. C. current, this being the type of lamp ordinarily used for projectors. The electrodes $a-b$ are supported by suitable carriers $a'-b'$ slidable in the fitting c toward and from each other to permit the regulation of the arc. The carriers $a'-b'$ each has a rack a^2-b^2 connected therewith, and mounted between and meshing with both said racks is a pinion c' .

The fitting c is pivotally mounted at c^2 , an adjusting screw c^3 acting upon the arm c^4 being provided, to permit the adjustment of the inclination of the electrodes. The above mechanisms are inclosed by the usual lamp house d .

The shaft e of the pinion c' has a universal joint e' in the length thereof to permit the angular adjustment of the electrodes, the end of this shaft being projected without the lamp housing d .

This construction is old and well known in

this art, the racks a^2-b^2 and pinion c' and its appurtenances constituting the means for affecting relative movement of the electrodes, herein referred to.

Carried by that end of the shaft e without the housing d is a beveled gear e^2 by means of which said shaft may be rotated to regulate the arc.

Current for the lamp is drawn from the line $f-g$, the positive side of which f has the usual rheostat f' or other variable resistance for stepping down the voltage to that required at the arc. The line is controlled by an ordinary switch h .

In connection with the means for imparting relative movement to the carbons, we employ a differential transmission gearing operatively connected with the shaft e by a shaft i , one end of which carries a beveled gear i' in mesh with the gear e^2 , and the other end of which is geared to the said transmission mechanism. The shaft i is provided with suitable universal joints i^2-i^3 , and one section thereof as i^4 telescopes within another section as i^5 to facilitate the installation of the regulator in relation to a projector.

The shaft e is provided with a hand wheel e^3 so connected therewith and with the gear e^2 that the automatic regulator may be disconnected from the shaft e to permit the manual control of the electrode carriers to facilitate trimming of the lamp, or adjustment of the arc in the event of failure of the automatic control.

The differential transmission mechanism is actuated by two motors A and B, the first of which is connected across the line $f-g$ to run at any predetermined constant speed, while the latter is connected in shunt with the arc, so as to have variable speed as determined by change of the potential of the arc circuit due to difference in potential of the circuit to, or variable resistance at, the arc.

The wiring system employed, Fig. 2, has been found satisfactory in use, but it is apparent that other systems may be employed to adapt our invention to different currents, or permit the use of different types of motors, without departing from the spirit and scope of the invention.

The motor A, as shown in the drawings, is a shunt wound motor, the armature of which is connected across the line $f-g$ by the wires f^2-g' , and the shunt circuit to the field j of which, has therein a rheostat or other variable resistance device g^2 by means of which the speed of the motor may be changed.

The armature of the motor B is connected in shunt with the arc circuit through the wires f^3-g^3 , and its field k is connected across the line $f-g$ by means of the wires f^4-g^4 . With the maximum current flow-

ing to the motor B, it acts as a shunt wound motor, but a drop of potential will not modify the field magnetism.

As will more fully appear hereinafter, the motor A acts upon the transmission so as to have a normal tendency to separate the electrodes $a-b$, while the motor B acts in opposition thereto, or so as to have a normal tendency to cause the electrodes to approach.

To secure this condition we so design the motors A and B that with the highest voltage in the arc circuit, the speed of the motor B will be approximately that of the motor A with the full resistance f' cut in the field shunt, and with the lowest voltage to be used at the arc, the speed of the motor B will be approximately that of the motor A with all resistance cut out of the shunt circuit to the field j . In this manner, the speed of the motor A may be so changed as to not only insure the normal working speed of the motor B being higher than the constant speed of the motor A, but to also set the regulator for any desired length of arc.

While it is not our intention to claim the specific transmission mechanism shown in the drawings in this application, such possesses certain characteristics essential to the regulator of our invention, and a more or less detailed description thereof will, therefore, be given.

This transmission comprises a casing m having mounted therein a shaft m' . Keyed or otherwise secured to this shaft is a gear m^2 meshing with a gear i^2 carried by the shaft i .

Idly mounted upon the shaft m' are two hubs $n-o$, the first of which carries a sun gear n' and a worm gear n^2 , and the latter of which carries a sun gear o' and a worm gear o^2 .

The gear n^2 is in mesh with a worm shaft n^3 connected with the armature shaft of the motor A, while the gear o^2 is in mesh with a worm shaft o^3 connected with the armature shaft of the motor B, the arrangement being such that the hubs $n-o$ are driven in opposite directions, thus permitting actuation of the shaft i to either cause the electrodes to recede from, or approach, each other.

Carried by the shaft m' is a fitting p having mounted at one side thereof two countershafts $q-r$. The shaft q carries two gears $q'-q^2$, the former of which is in mesh with the gear n' , while the shaft r carries two gears $r'-r^2$ the former of which is in mesh with the gear o' , and the latter of which is in mesh with the gear q^2 . The intermediate gears q^2-r^2 permit the planet gears $q'-r'$ to be rotated with their respective sun gears $n'-o'$.

The counterweight s carried by the fitting p substantially diametrically opposite the shafts $q-r$, is provided to insure easy and uniform running of the planet gear system.

By transmitting power to the transmission mechanism by means of worm shafts driven by the motors A—B, not only is a desired reduction of speed secured, but the conversion of the two connected motors into a motor generator set as the result of one motor driving the armature of the other, is prevented. While this condition would not generate sufficient current to choke the line, it would prevent the driving of the shaft m' as a result of the differential speed of the two sun gears, which would destroy the effectiveness of the regulator.

In describing the operation of the herein described regulator, reference will be had to the specific mechanical and electrical conditions presented in the drawings, the line current being 110 volts D. C. and the resistance f' being so set as to deliver approximately 55 volts to the electrodes at an amperage of approximately 60, it being understood that this is merely an arbitrary selection of conditions.

In starting the device, the resistance g^2 will be cut in to deliver any desired voltage, less than 110 volts, to the field j of the motor A, say 55 volts.

When the switch h is closed in starting, the gap between the electrodes $a-b$ will prevent the flow of any current through the arc circuit, the entire strength of the current flowing through the shunt circuit f^3-g^3 to the armature of the motor B, which current will be in excess of that for which the arc circuit is set. At the same time the field h will be energized by a current at the full voltage of the line. The closing of the line circuit will also place the armature of the motor A in circuit, with the full voltage of the line, and the field j of said motor in circuit with the line, with the resistance cut in, as heretofore stated.

With these conditions established, both motors A and B will start, the motor A immediately picking up until it reaches that speed for which the rheostat g^2 is set, while the motor B by reason of the increased current to its armature will develop a speed in excess of that which will be developed by the voltage for which the arc is set.

Thereafter, while the regulator is in operation, the motor A will continue to run at a constant speed subject, however, to slight fluctuations due to conditions on the line, while the speed of the motor B will vary in a manner which will be more particularly described hereinafter.

The rotation of the shaft n^3 by the motor A will drive the sun gear n' at a constant speed, while the rotation of the gear o^3 will drive the sun gear o' at a speed proportionate with that of the motor B, both gears, however, being driven at a much reduced speed by reason of the transmission mechanism. Since the highest possible speed of

the motor B when the arc is set for the highest voltage desired to be used, is approximately the speed of the motor A with the entire resistance cut into the field shunt, it is apparent that with no current passing through the electrodes, the speed attained by the motor B will be in excess of that which it will attain after the arc has been struck, so that there will be a considerable difference of speed at this period between the gears o' and n' , thus causing the fitting p to rotate about the axes of said sun gears, thus rotating the shaft m' and through it the shaft i , and through the gears i' and e^2 , the shaft e . This causes the electrode carriers $a'-b'$ to approach each other until the electrodes are in physical contact.

The instant the electrodes touch, the arc circuit will be short circuited through the electrodes, practically cutting out the shunt circuit f^3-g^3 to the armature of the motor B. During all this time the motor A and the sun gear n' will be rotating at constant speed so that with the stoppage of the motor B, the conditions will be reversed, the speed of the gear n' exceeding that of the gear o' , which is practically at rest, thus quickly separating the electrodes and striking the arc and continuing to separate them until the resistance at the arc reaches that determined by the rheostat f' and the rheostat g^2 .

With the striking of the arc, current will flow to the armature of the motor B, which will begin to turn, gradually gathering speed as the resistance at the arc increases, until it attains its maximum speed with a given length of arc. This speed is always slightly in excess of the constant speed of the motor A so that while the arc is burning, the fitting p will be always turning, but very slowly, under the control of the gear o' , thus imparting a constant minute feeding movement to both carbons, which movement is substantially coincident with the rate of consumption of the carbons.

If, for any reason, such as imperfections in the carbons, or lack of accuracy in the different mechanisms, the rate of consumption of the carbons be less than the rate of their approach under the control of the motor B, the resistance at the arc will be reduced and the speed of the motor B will be correspondingly reduced, so that the motor A, which has a normal tendency to separate the electrodes, will become operative to retard the feed until the normal gap is restored. If, on the other hand, the rate of consumption of the carbon is greater than the rate of feed, the resistance at the arc will be increased and there will be a corresponding increase in the speed of the motor B, thus accelerating the feed until the normal arc is reached. These fluctuations, however, are very small, the operation of

the motors A and B in the manner described maintaining a substantially uniform arc, the effects of variations in the resistance of the arc being merely corrective, and not the primary actuating medium.

If it be desired to lengthen the arc, additional resistance may be cut in the field shunt to the motor A, thus increasing the speed of the motor A with relation to that of the motor B. This, when striking the arc, prolongs the interval before the motor B attains its maximum speed with the new arc resistance, although thereafter the feeding conditions will be substantially as heretofore referred to.

Likewise if it is desired to shorten the gap, resistance will be cut out of the shunt field, thus reducing the speed of the motor A so that the motor B will attain its maximum speed with the new arc length in a shorter interval. Thereafter the motors A and B run at substantially the same relative speeds as with the longer arcs, feed always being uniform and proportionate to the carbon consumption.

In actual practice, we have found that the fluctuation in the resistance at the arc, seldom exceeds one-tenth of a volt and that these fluctuations occur at different intervals, and that when there is a variance in such resistance the speed of the motor B will instantly respond to correct this condition, and that response is the same whether the resistance increases or decreases. The result is a substantially uniform length of arc and constant light intensity, which particularly adapts the regulator for use in cinematographic projectors, and similar devices requiring this condition.

While in actual practice we have found the particular transmission mechanism and wiring arrangement shown in the drawings, to give highly satisfactory results, it is apparent that the specific details of said mechanism and said electrical conditions are immaterial, since such are susceptible of wide variation, while preserving the essential characteristics of the regulator. If desired the motor construction may be modified to adapt the invention to an A. C. line or to different voltages upon a D. C. or an A. C. line. The speeds of the motors A and B may be governed by changes in the potential of the armature circuits instead of the field, and vice versa. In fact the electrical conditions are subject to that wide range of variations within the skill of the ordinary electrician, while still preserving the essential characteristics of the invention.

The motor A instead of being driven from the same mains as those supplying power to the arc, may be driven from entirely different mains, it being essential, however, that the arc motor, or motor B, be connected in

shunt with the electrodes. For convenience of expression in the claims, the motor A will be referred to as the line motor and the motor B as the arc motor, said terms being considered with due regard to the possible wide range of electrical conditions above referred to.

While, in actual practice, it is preferable to use an electric motor having constant speed, it is apparent that since the invention merely requires that one element of the differential be rotated at substantially constant speed, the source of power for actuating this element, considering the invention broadly, is immaterial.

Having described the invention, what we claim as new and desire to have protected by Letters Patent is:—

1. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a motor operative upon said transmission mechanism to impart thereto a normal tendency to separate the electrodes, means whereby continuous constant power is developed in said motor, and a motor having a different speed than said first named motor operative upon said transmission mechanism to impart thereto a normal tendency of the electrodes to approach each other and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed.

2. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, actuating means therefor comprising two motors, a differential transmission mechanism actuated thereby, means whereby continuous constant power is developed in one of said motors while the arc is burning, to impart to said mechanism a normal tendency to separate the electrodes, and means whereby the other motor will be rotated at variable speed in accordance with change of potential due to variable resistance at the arc, whereby said motors are operative through said transmission mechanism to cause the electrodes to approach each other at a speed governed by the difference in speed of said motors.

3. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, actuating means therefor comprising a differential speed transmission mechanism operatively connected with said means, means whereby continuous constant power will be applied to

said transmission mechanism to impart thereto a normal tendency to separate said electrodes, and independently operative means having variable speed determined by change of potential due to variable resistance at the arc while the lamp is burning, said last named means having a normal tendency to cause said electrodes to approach each other, and having a normal relatively higher speed than said first named means, whereby when the arc is burning, there will be a gradual uniform feed of the electrodes with relation to each other at substantially the same rate as the consumption of the carbons.

4. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a line motor continuously rotated at constant speed having a normal tendency to separate said electrodes, an arc motor connected in shunt with the electrodes, whereby it will rotate at variable speed determined by change of potential due to variable resistance at the arc, and a differential transmission mechanism acted upon by said motors respectively and operatively connected with said first named means.

5. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a motor operative upon said transmission mechanism, to impart thereto a normal tendency to separate the electrodes, means whereby continuous constant power is developed in said motor, a motor having a different speed than said first named motor operative upon said transmission mechanism to cause the electrodes to approach each other and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed, and a speed changing device operatively connected with said first named motor, whereby the length of the arc gap may be varied through a change of speed in said motor.

6. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a line motor continuously rotated at constant speed having a normal tendency to separate said electrodes, an arc motor connected in shunt with the electrodes, whereby it will rotate at variable speed determined by change of potential due to variable resistance at the arc, a speed changing device operatively connected with said first named motor, whereby the length of the arc gap may be

varied through a change of speed in said motor, and a differential transmission mechanism acted upon by said motors respectively and operatively connected with said first named means.

7. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a motor operative upon said transmission mechanism, to impart thereto a normal tendency to separate the electrodes, means whereby continuous constant power is developed in said motor, a motor having a different speed than said first named motor operative upon said transmission mechanism to cause the electrodes to approach each other and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed, and a variable resistance member included in the circuit to one of the elements of said constant speed motor, whereby the length of the arc gap may be varied through a change of speed in said motor.

8. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a line motor continuously rotated at constant speed having a normal tendency to separate said electrodes, an arc motor connected in shunt with the electrodes, whereby it will rotate at variable speed determined by change of potential due to variable resistance at the arc, a variable resistance member included in the circuit to one of the elements of said constant speed motor, whereby the length of the arc gap may be varied through a change of speed in said motor, and a differential transmission mechanism acted upon by said motors respectively and operatively connected with said first named means.

9. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a constant speed motor operative upon said transmission mechanism, and a motor having a different speed than said first named motor also operative upon said transmission mechanism and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed, said transmission

mechanism embodying therein means whereby transmission of power from one of said motors to the other is prevented.

10. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a differential transmission mechanism, operative connections between said transmission mechanism and said means, a constant speed motor operative upon said transmission mechanism, a motor having a different speed than said first named motor also operative upon said transmission mechanism and connected in shunt with said electrodes, whereby the normal difference in speed of said motors will impart gradual feeding movement to said electrodes and the speed of said last named motor will vary with the resistance at the arc to compensate for irregularities in said feed, and a speed changing device operatively connected with said first named motor, whereby the length of the arc gap may be varied through a change of speed in said motor, said transmission mechanism embodying therein means whereby transmission of power from one of said motors to the other is prevented.

11. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a line motor continuously rotated at constant speed having a normal tendency to separate said electrodes, an arc motor connected in shunt with the electrodes, whereby it will rotate at variable speed determined by change of potential due to variable resistance at the arc, a speed changing device operatively connected with said first named motor, whereby the length of the arc gap may be varied through a change of speed in said motor, and a differential transmission mechanism acted upon by said motors respectively and operatively connected with said first named means, said transmission mechanism embodying therein means whereby transmission of power from one of said motors to the other is prevented.

12. An automatic arc regulator embodying therein means whereby relative movement may be imparted to the electrodes, a shunt wound line motor connected across the line, a variable resistance in circuit with the field of said motor, an arc motor, the armature of which is connected in shunt with the electrodes, and the field of which is connected across the line, whereby said line motor will run at constant speed as determined by said variable resistance, and said arc motor will rotate at variable speed determined by change of potential due to variable resistance at the arc, a differential transmission mechanism acted upon by said motors respectively, said line motor being operative through said mechanism to have a normal tendency to separate the electrodes,

and said arc motor being operative through
said transmission mechanism to cause the
electrodes to approach each other at a speed
governed by the difference in speed of said
5 motors, and operative connections between
said transmission mechanism and said first
named means.

In witness whereof we have hereunto af-

fixed our signatures, in the presence of two
subscribing witnesses, this 3rd day of No- 10
vember, 1919.

JAMES E. SOONS.
HARRY ROBINSON.

Witnesses:

FRIEDA KOEHLER,
HARRIET LE BERTHON.