No. 704,495. Patented July 15, 1902.

A. M. ARTER.

ELECTRIC ARC LAMP.

(Application filed Jan. 12, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

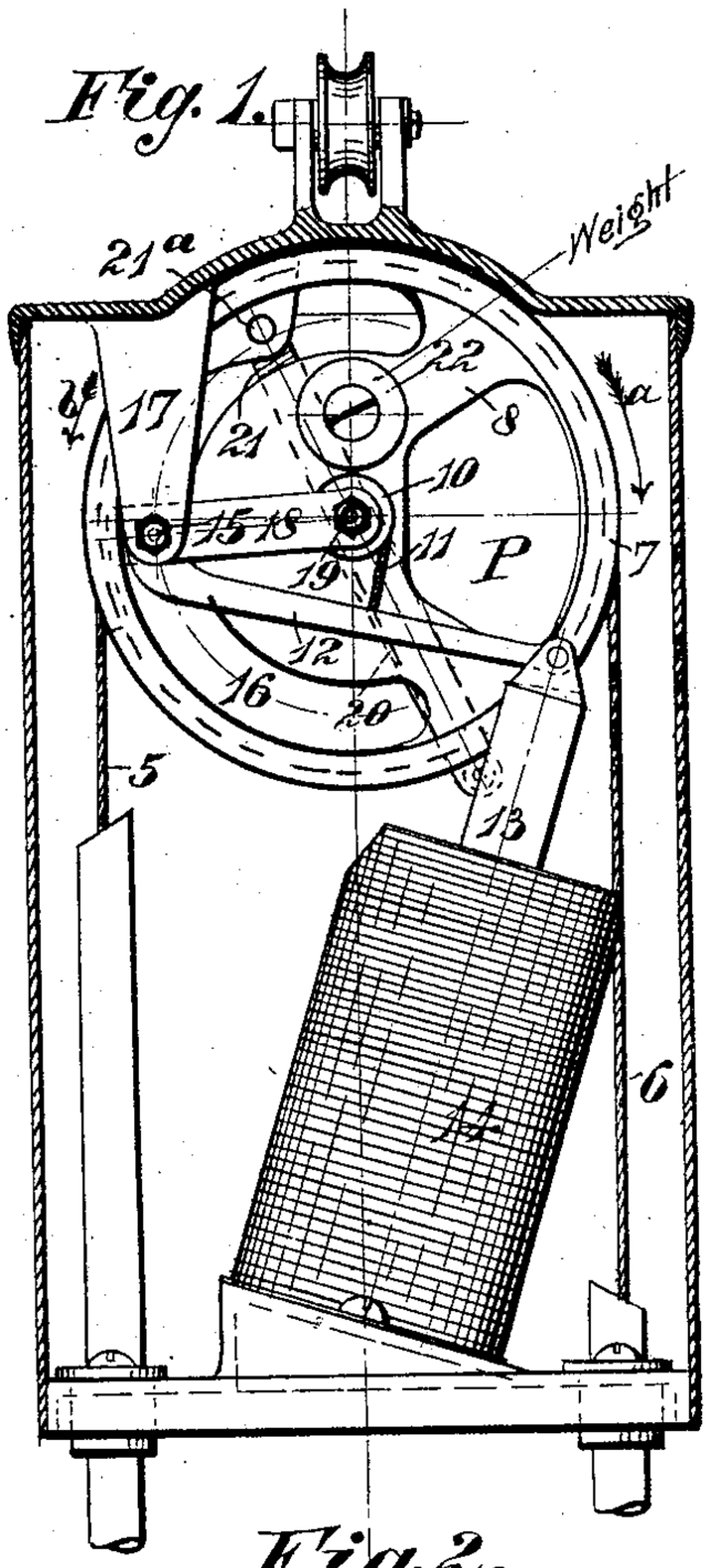


Fig. 4.

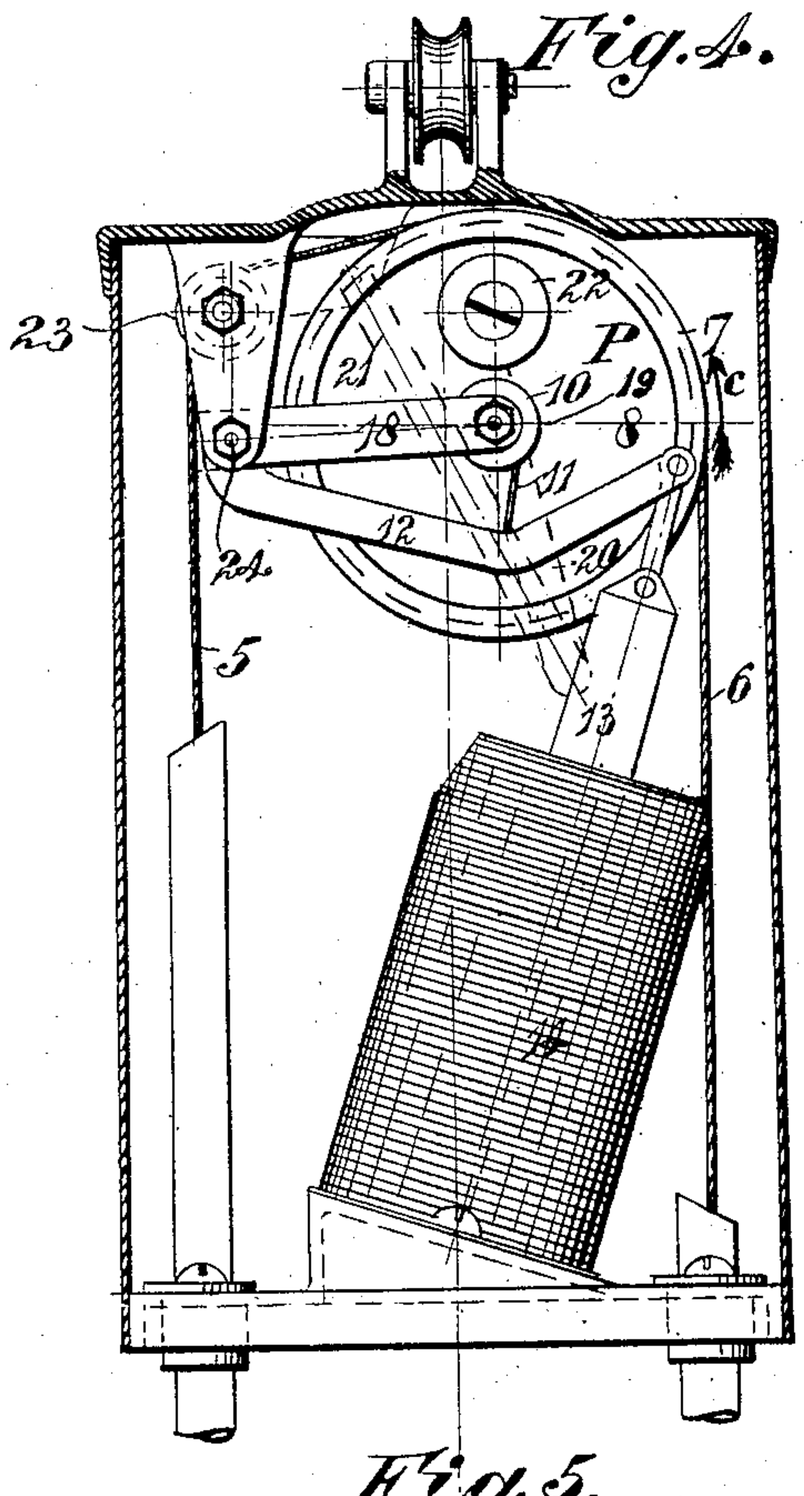


Fig. 2.

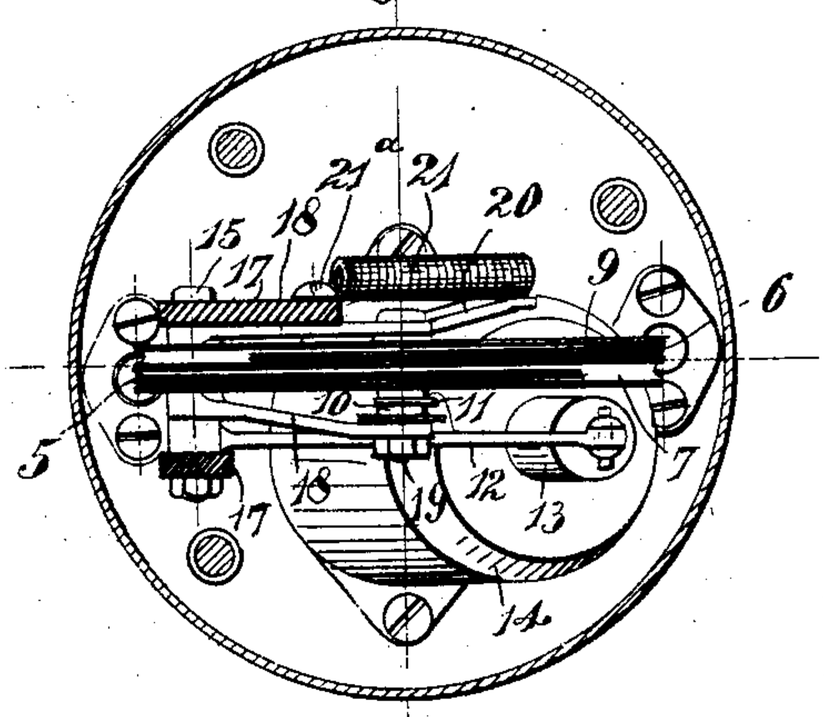
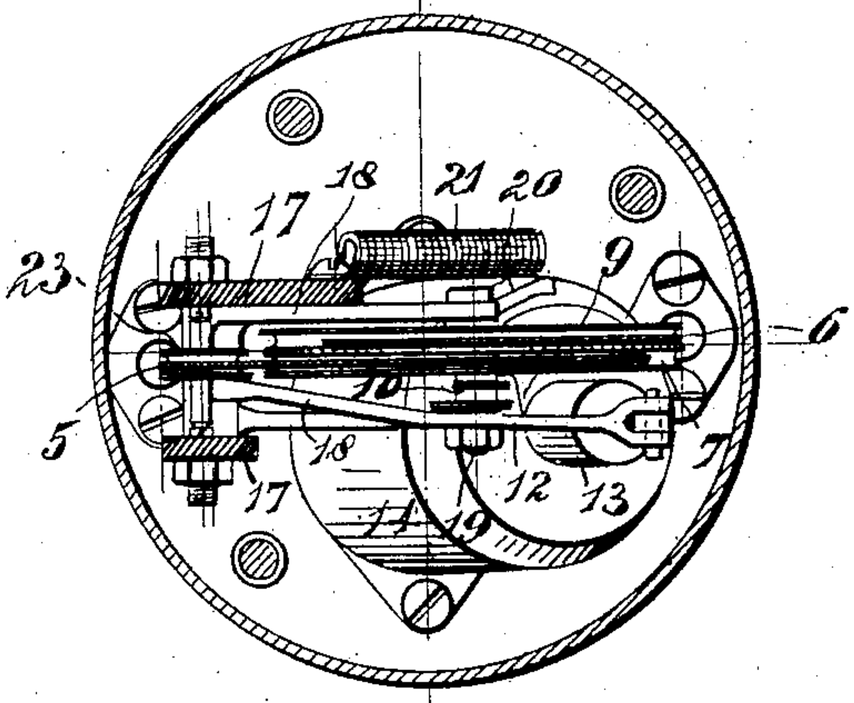


Fig. 5.



Witnesses.
Geo. E. Breck.
Chas. R. Wright Jr.

Inventor.
A. M. Arter
by A. S. Pattison
Atty

No. 704,495. Patented July 15, 1902.

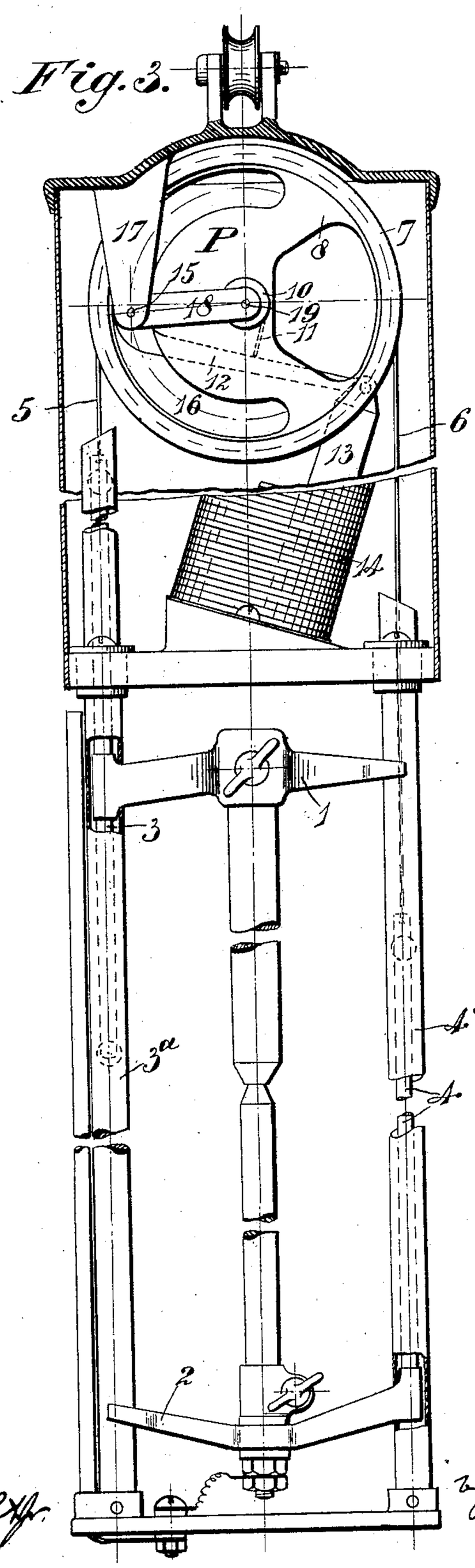
A. M. ARTER.

ELECTRIC ARC LAMP.

(Application filed Jan. 12, 1899.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.



Witnesses.
Geo. E. Finch,
Chas. R. Wright Jr.

Inventor
A. M. Arter,
by A. S. Pattison,
Atty.

UNITED STATES PATENT OFFICE.

ARTHUR MARSHALL ARTER, OF HAMMERSMITH, ENGLAND.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 704,495, dated July 15, 1902.

Application filed January 12, 1899. Serial No. 702,009. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR MARSHALL ARTER, a subject of the Queen of Great Britain and Ireland, residing at Hammersmith, in the county of Middlesex, England, have invented Improvements in Electric-Arc Lamps, of which the following is a specification.

This invention consists of improvements in the carbon-adjusting apparatus of electric-arc lamps which are adapted to work with either continuous or alternating currents, and has for its object to provide such apparatus that will be efficient in operation and yet simple and cheap in construction. For this purpose, according thereto, the holder of the upper carbon is made heavier than that of the lower carbon, and both are connected to opposite sides of the periphery of a wheel that is suitably supported by means of a spring or an equivalent and is provided with a part of smaller diameter, to the periphery of which is connected the core of a solenoid, the arrangement being such that if no current be passing through the lamp the weighted top carbon will normally touch the bottom carbon, so that upon the completion of the lamp-circuit an electric current will pass through the carbons and the solenoid and will actuate the core of the latter, so as to pull the axle of the wheel down against the action of the spring or its equivalent and also to rotate the wheel partially, and thereby to move the carbons a suitable distance apart to strike the arc, after which the carbons will be similarly kept sufficiently apart against the action of the weighted top-carbon holder, which will gradually feed them forward.

Figures 1 and 2 of the accompanying drawings represent an example of carbon-regulating apparatus according to this invention in sectional elevation and sectional plan, respectively; and Fig. 3 is a broken elevation of a lamp provided therewith. Figs. 4 and 5 are views similar to Figs. 1 and 2, respectively, of another example of apparatus according to this invention.

In the lamp represented in Figs. 1, 2, and 3, which is a focusing-lamp, the positive and negative carbon holders 1 and 2, respectively, are carried by rods 3 and 4, guided by and in tubes 3^a and 4^a, and have cords 5 and 6 connected to them, the cord 5 from the top-carbon holder 1 passing to a groove 7 in the periphery of the portion 8 of larger diameter of a differential pulley P, to which it is secured, while the cord 6 from the bottom-carbon holder 2 passes to another groove 9 on the portion 8 of the differential pulley and is also secured thereto, the cords depending from opposite sides of the pulley. The boss 10 of the differential pulley P has secured to it a cord 11, which depends from the same side as the cord 6 of the bottom-carbon holder and is attached at its lower end to a lever 12, connected at its free end to the core 13 of a series solenoid 14 and mounted at its other end on a spindle 15, which passes through a slot 16 in the differential pulley P and is carried by a fixed support 17 and on which is also mounted the boss of a forked arm 18, whose free end carries the differential pulley P on a spindle 19. To an extention 20 of the forked arm 18 there is secured a spring 21, which is attached at 21^a to the fixed framework of the lamp and supports the differential pulley P. In the case of an alternating-current lamp the solenoid-core is preferably composed of disks of iron arranged at right angles to the axis of the solenoid. When the electric current is switched on with the carbons in contact, it energizes the solenoid 14, which by means of its core 13, the lever 12, and the cord 11 revolves the pulley P about the spindle 15 against the action of the spring 21, while the weight of the top-carbon holder rotates the pulley slightly in the direction indicated by the arrow *b* of Fig. 1, so that the carbons both descend together for a short distance in contact with each other, and as the tension of the spring, and consequently the resistance to the lowering of the axis of the pulley, increases the solenoid stops the rotation of the pulley about its own axis in the said direction and strikes the arc by continuing to revolve the pulley P, together with the forked arm 18, about the spindle 15. The arrangement is preferably such that during this continued drawing down of the pulley P by the solenoid the pulley is not thereby rotated relatively to the forked arm 18 in the direction of the arrow *a* in Fig. 1, as in that case a weaker spring and a weaker solenoid can be used than would otherwise be necessary. As the resistance of the arc increases through

the burning away of the carbons a correspondingly-decreased current passes through the solenoid, so that the pull of the core plus the weight of the bottom-carbon holder no longer counterbalances the pull of the weighted top-carbon holder, which then partly rotates the pulley P in the direction indicated by the arrow *b* in Fig. 1, lowering the top carbon and raising the bottom carbon until the increased current passing through the solenoid stops further rotation of the pulley, and thus regulates the length of the arc between the carbons. As the carbons burn away the weight supported by the spring 21 is of course reduced, and the spring slightly raises the forked arm 18, and with it the pulley P, so rendering the position of the arc slightly higher than it would otherwise be. The strength of the spring 21 is such that while it supports the pulley and the parts carried thereby at a suitable height when no current is passing through the lamp it expands to such an extent when the arc is being struck that the resistance of the arc is consistent with the passage of normal current through the solenoid. When the lamp is intended to be worked by continuous current, the pulley is preferably so weighted by means, it may be, of a weight 22 (not shown, for the sake of clearness, in Fig. 2) or its center of gravity so arranged that it will approximately compensate for the gradual decrease in the tendency of the carbon-holders to approach each other, due to the unequal consumption of the two carbons. The diameter of the portion of the pulley P on which the cords 5 and 6 rest may be then such that the pulley will make about half a revolution during the consumption of a pair of carbons and that the weight of the pulley will, as in the example now being described, act in gra-dually-decreasing opposition to the weight of the top-carbon holder during the first half of the travel and as a gradually-increasing assistance thereto during the second half. The lengths of the solenoid and its core must, of course, always be such as to allow of their properly regulating the length of the arc notwithstanding the fact that the core will be gradually moved outward during the winding up by the pulley P of the cord 11, attached to the core.

The spring 21 may be arranged, as shown, in a somewhat-inclined position, so as to give a more uniform turning moment in relation to the spindle 15 for equal angular movements of the lever 12 than would be the case with a vertical spring, in order that equal variations in current may cause the solenoid to produce more nearly equal movements of the axle of the differential pulley. It will be evident that with this inclined arrangement of the spring a force less than would be required if the spring were vertical will be sufficient after the expansion of the spring, due to the weight of the parts supported by it, to produce the requisite lowering of the pulley in striking the arc and that a more convenient equivalent of a longer vertical spring will be thereby obtained.

The cord 11, that passes around the boss 10 of the differential pulley P, may be connected directly to the solenoid-core 13 instead of indirectly, and in that case the center line of the core may advantageously be tangential to the periphery of the boss of the pulley. Instead of a simple series solenoid it is better to employ a differentially-wound solenoid in which the strength of the series winding is greater than that of the shunt-winding, preferably being about four times the strength of the latter. When the lamp is intended to be worked in series with others, such a differentially-wound solenoid (or its equivalent, as a series solenoid having a separate shunt-coil to act in opposition to its series coil) is necessary, as also is a dash-pot or its equivalent.

Instead of connecting the holders 1 and 2 with the wheel controlled by the solenoid by flexible means, such as the cords 5 and 6, the holders may be positively connected to the wheel by means of toothed racks engaging with teeth formed on the wheel. In this case the apparatus might with suitable modifications be inverted—*i. e.*, the wheel and its solenoid might be placed below the carbons.

In lieu of leading the cord 5 to the top-carbon holder 1 directly thereto from the pulley P, as in the example shown in Figs. 1, 2, and 3, it may, as in the example shown in Figs. 4 and 5, be passed over a guide-pulley 23, which may, as shown, be arranged slightly below the starting position of the highest point of the pulley P. In this case the forked arm 18, carrying the differential pulley, may, as shown, be pivoted, so as to turn about an axis 24 outside the pulley P. When the electric current is switched on with the carbons in contact, it energizes the solenoid 14, which by means of its core 13, the lever 12, and the cord 11 consequently slightly pulls down the arm 18, and with it the pulley P, against the action of the spring 21, the solenoid thus lowering the bottom-carbon holder 2 and by its tendency to rotate the pulley in the opposite direction to that indicated by the arrow *c* gradually overcoming the tendency of the weighted top-carbon holder to rotate the pulley in the direction indicated by arrow *c*, and thereby striking the arc. During this movement, but before striking the arc, the top-carbon holder 1 is slightly lowered when the guide-pulley 23 is arranged as shown; but in some cases the top-carbon holder may be unaffected. The subsequent action of the lamp is the same as that hereinbefore described with reference to Figs. 1, 2, and 3.

What I claim is—

1. In an electric-arc lamp, the combination of two carbon-holders, a wheel, a horizontal axle on which the said wheel is mounted, means for supporting the said axle elastically, a fixed support on the same side of the said

axle as the said two carbon-holders, a link connecting the said axle to the said fixed support, means for connecting the said carbon-holders to the said wheel so that the rotation of the latter will move the said carbon-holders in opposite directions, a mechanical device adapted to decrease the distance between the said carbon-holders, and an electromagnetic device constructed and arranged to counterbalance, to overcome, and to fall short of the action of the said mechanical device in accordance respectively with the passage through the carbons of normal, more than normal, and less than normal current.

2. In an electric-arc lamp, the combination of two carbon-holders, a wheel having a horizontal axle carried by a yielding support, flexible connections passing from the said carbon-holders to opposite sides of and secured to the said wheel, a solenoid whose core is connected by a flexible connector to the same side of the said wheel as that to which the lower-carbon holder is connected, and means for automatically moving the said carbon-holders toward each other on decrease of current passing through the carbons carried by the said carbon-holders.

3. In an electric-arc lamp, the combination of two carbon-holders, a fixed support, an arm pivoted to the said support, an axle secured to the outer end of the said arm and supported by spring force or gravity, a wheel mounted on the said axle, means for connecting the said carbon-holders to the said wheel so that the rotation of the latter will move them in opposite directions, a boss or portion of smaller diameter secured to the said wheel, a lever having a fixed pivot, a solenoid whose core is connected to the outer end of the said lever, a flexible connector secured to an intermediate point of the said lever and coiled around and attached to the said boss so that a pull thereon will tend to lower the said axle and to rotate the said wheel in the direction to move the said carbon-holders away from each other, and means for automatically moving the said carbon-holders toward each other on decrease of the current passing through the carbons carried by the said carbon-holders.

4. In an electric-arc lamp, the combination of two carbon-holders, a wheel having a horizontal axle, means for connecting the said carbon-holders to the said wheel so that rotation of the latter will move the said carbon-holders in opposite directions, a boss or portion of smaller diameter fixed to the said wheel, a solenoid whose core is connected to the said boss or portion of smaller diameter and is adapted to rotate the said wheel so as to move the carbon-holders away from each other on an increase of the current passing through the carbons carried by the said holders, and means for automatically moving the said carbon-holders toward each other on a decrease of the said current.

5. In an electric-arc lamp, the combination of two carbon-holders, a fixed support, an arm pivoted to said support, an axle secured to the outer end of the said arm, a wheel mounted on the said axle, means for connecting the said carbon-holders to the said wheel so that the rotation of the latter will move them in opposite directions, means for automatically and electrically lowering the said wheel and rotating it so as to cause the said carbon-holders to move away from each other on increase of the current passing through the carbons carried by the said holders, means for automatically moving the said carbon-holders toward each other on decrease of the current passing through the said carbon-holders, and a spring supporting the said axle and arranged in an inclined position so as to give a more nearly uniform turning moment about the axis of the pivot of the said arm than would be the case with a vertical spring.

6. Apparatus for moving two bodies in opposite directions in accordance with divergences of an electrical current from the normal, comprising a wheel, a horizontal axle on which the said wheel is mounted, means for supporting the said axle elastically, a fixed support on the same side of the said axle as the said two bodies, a link connecting the said axle to the said fixed support, means for connecting the said two bodies to the said wheel so that rotation of the latter will move the bodies in opposite directions, a mechanical device adapted to move the said bodies in certain directions, and an electromagnetic device adapted to counterbalance, to overcome, and to fall short of the action of the said mechanical device in accordance respectively with the passage through the said electromagnetic device of normal current, more than normal current, and less than normal current.

7. Apparatus for moving two bodies in opposite directions in accordance with divergences of an electrical current from the normal, comprising a wheel, a horizontal axle on which the said wheel is mounted, means for supporting the said axle elastically, a fixed support on the same side of the said axle as the said two bodies, a link connecting the said axle to the said fixed support, means for connecting the said two bodies to the said wheel so that rotation of the latter will move the said bodies in opposite directions, a mechanical device adapted to move the said bodies in certain directions, and an electromagnetic device adapted to counterbalance, to overcome, and to fall short of the action of the said mechanical device in accordance respectively with the passage through the said electromagnetic device of normal current, more than normal current, and less than normal current, the said electromagnetic device including a lever having a fixed fulcrum, a connection from an intermediate point of the said lever to the said wheel, and a solenoid having

a core connected to the outer end of the said lever.

8. An electric-arc lamp, comprising a rotatable body, carbons operatively connected with the said rotatable body to move in opposite directions when the said body is rotated, an electrically-controlled actuating means operatively connected with and adapted to rotate the said body in one direction, and mechanical means operatively connected with and adapted to rotate the said body in the opposite direction.

9. An electric-arc lamp comprising an elastically-supported rotatable body, carbons operatively connected with the said body and adapted to be moved thereby in opposite directions when the body is rotated, an electrically-controlled actuating means acting against the elastic support of the said body and operatively connected with the body to rotate it in one direction, and a mechanical means operatively connected with the said body and adapted to rotate it in the opposite direction, said mechanical means also acting against the said elastic support of the rotatable body.

10. An electric-arc lamp comprising an elastically-supported frame, a rotatable body journaled therein, an electrically-controlled actuating means operatively connected with the said rotatable body and adapted to rotate the same in one direction for separating the carbons, and a mechanically-controlled means operatively connected with the carbons and with the rotatable body and adapted to move the carbons and the rotatable body in opposition to the said electrically-controlled actuating means.

11. An electric-arc lamp comprising a rotatable body, two carbons, separate connections between the carbons at opposite sides of the axis of the said rotatable body, mechanical means for rotating the body in one direction for causing the carbons to approach, electrical means operatively connected with the rotatable body and adapted to rotate it in opposition to the said mechanical means, the rotatable body having a weight so disposed thereon as to act in opposition to the said mechanical means during the first portion of the consumption of the carbons, and acting in unison therewith during the consumption of the remaining portion of the carbons.

12. An electric-arc lamp comprising a rotatable body, carbons operatively connected with the said body at opposite sides of its axis, the connections extending therearound in opposite directions, mechanical means operatively connected with the rotatable body for causing the said carbons to approach each other, electrical means operatively connected with the rotatable body to cause it to rotate in opposition to the mechanically-operating means, the said rotatable-body-carrying means compensating for the consumption of the said carbons.

Signed at 77 Cornhill, in the city of London, England, this 30th day of December, 1898.

ARTHUR MARSHALL ARTER.

Witnesses:

EDMUND S. SNEWIN,

HENRY MAYKELS.