(No Model.) 2 Sheets—Sheet 1.

C. E. HARTHAN.

ELECTRIC ARC LAMP.

No. 543,729. Patented July 30, 1895.

FIG. 1.

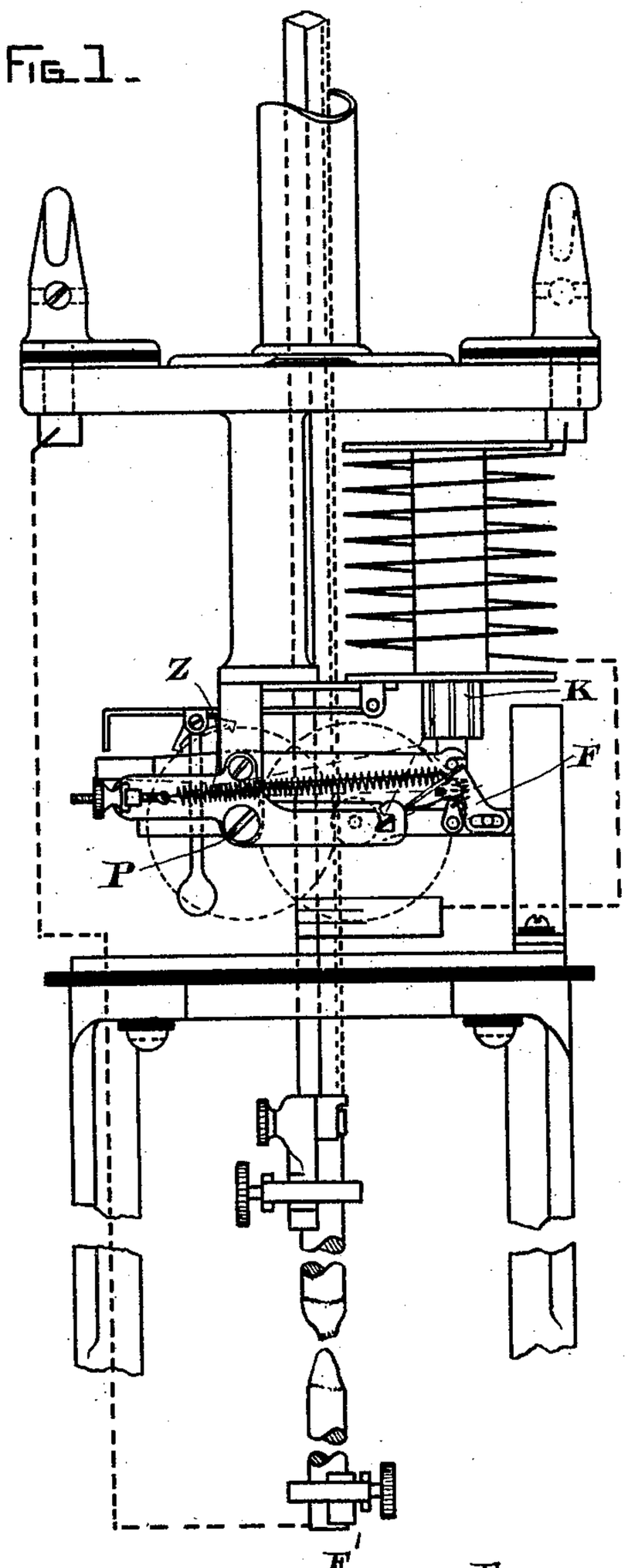

FIG. 2.

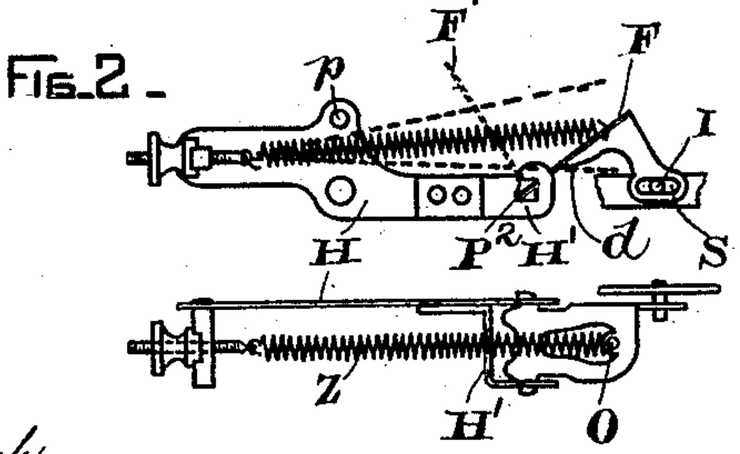

FIG. 3.

WITNESSES.
Henry Westendarp
J. J. Johnston.

INVENTOR.
Charles E. Harthan by
Geo. R. Blodgett
atty.

(No Model.) 2 Sheets—Sheet 2.

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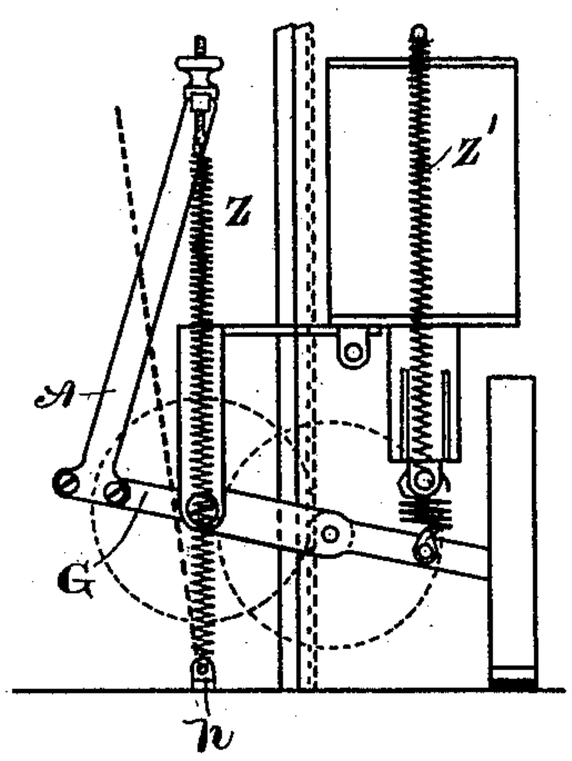

FIG. 4.

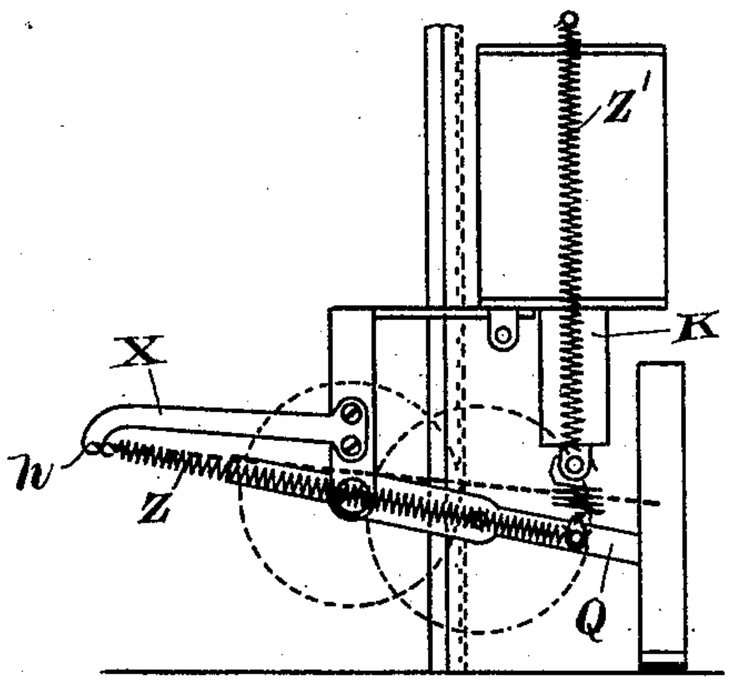

FIG. 5.

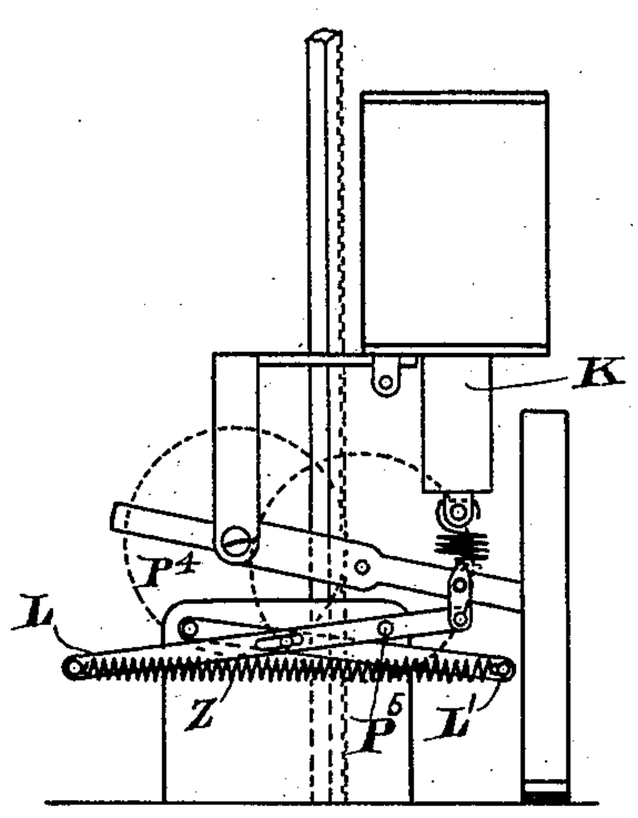

FIG. 6.

WITNESSES.

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UNITED STATES PATENT OFFICE.

CHARLES E. HARTHAN, OF LYNN, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE GENERAL ELECTRIC COMPANY, OF SCHENECTADY, NEW YORK.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 543,729, dated July 30, 1895.

Application filed November 21, 1894. Serial No. 529,476. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. HARTHAN, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Alternating-Current Arc Lamps, of which the following is a specification.

My invention relates to electric-arc lamps; and it has for its object to provide a lamp in which some of the difficulties attendant upon alternating-current lamps as generally constructed may be obviated and their efficiency increased.

In the operation of alternating-current arc lamps upon constant-potential circuits it is necessary to use a comparatively fine and soft quality of carbon in order that the arc may start easily and may also be maintained during the normal running of the lamp. A hard carbon will not ordinarily give sufficient gas or vaporized carbon in the arc to maintain it with certainty. It has therefore now become the custom to use so-called "cored" carbons—that is, carbons having an inner core composed of a material softer and more easily volatilized than the other part of the electrode. The use of such carbons in alternating arc lamps on a constant-potential circuit leads, however, to the following difficulty: When the lamp is started into operation with a new carbon the soft inner core extending to the tip of the electrode is quickly volatilized and produces a large amount of hot and highly-conducting carbon vapor, thus largely reducing the resistance of the arc. In lamps which are regulated solely by the action of the series coil the core is drawn up to lengthen the arc; but notwithstanding this the resistance on starting a lamp not provided with the improvements of this invention is still so low, even when the series magnet has lifted the core, that an abnormally-heavy current flows and a so-called "flaming" arc is produced. When therefore a number of such lamps are turned on simultaneously the heavy demand for current overloads the dynamo and the lamps may be unable to start normally at all.

The same condition of overload may be brought about in case the lamps have been burning for a while or until the softer interior carbon has been burned back from the point of the electrode. The carbons are then cold when the lamps are brought into operation and there is not enough hot conducting-vapor to maintain the arc formed when the series coil attracts its core. When the arc is thus extinguished the carbons fall together, and this action is repeated very rapidly, giving rise to an annoying flickering or vibration, which continues until the carbon points have been sufficiently heated to reduce the resistance of the arc; but this vibration operates the feeding mechanism of the lamp, and in consequence when the arc starts it is much too short, even in the extreme attracted position of the core. The resistance being thus cut down, the same condition of overload is produced at the station. It is not sufficient to overcome this difficulty to give the solenoid-core an exceptional traverse, because, the lifting of the upper carbon and its release occurring only at the extreme position of the core, a long traverse acts to diminish the sensitiveness of the feed, and therefore considerable current variation occurs before the regulation of the arc length. The same condition of overload affects with equally evil results the operation of the incandescent lamps in the same circuit with the arc lights, reducing their candle-power and blackening the globes.

The present invention aims to obviate these objections and enables me to start lamps under all conditions with either their normal current or with current less than the normal, which gradually rises to the normal current. This is precisely the opposite of what takes place in commercial alternating arc lamps at the present time, upon which this invention is founded, wherein the lamp starts at an abnormally-heavy current and gradually comes down to a normal. To illustrate specifically, a thirteen-ampère thirty-volt lamp may be started, if constructed in accordance with my present improvements, with as small a current as six or eight ampères, gradually running up to its full current of thirteen ampères, and, upon a slight decrease of the current, feeding the carbons together. Without these improvements the current at starting may

easily run up to twenty-two ampères, an increase of over fifty per cent. Where a circuit has a number of lamps in operation, and these are required to be started simultaneously, this leads to the difficulties already pointed out. My invention overcomes these difficulties and attains the ends just described by applying to the solenoid-core a spring operating to assist the core in its rise and so arranged that when the core is at its lowest or unattracted position the spring is least effective, and gradually becomes increasingly effective as the core is attracted into the coil, and consequently as the attractive force in the coil becomes less and less. I have called this action of the spring "progressive," and where that word occurs in this specification it is intended to have the significance just pointed out.

The lifting power of the series magnet, while sufficient throughout a certain range, is not, without the spring, easily made sufficient through such a range as is required to separate the carbons at the start, when the core is down to the end of the carbon and the resistance of the arc, therefore, is abnormally low. The spring, acting under an increasing leverage, serves two purposes. It tends in any position in which the core may be to assist the uplifting power of the core, and in the higher positions of the core has an effect which increases this lifting power, and thereby gives the core the power to lift, even though its magnetic effect may have fallen off.

The addition of an assisting-spring of uniform pull throughout its entire range of movement will render possible a less number of ampère turns in the series coil by decreasing the work it has to do; but it does not change the length of traverse. The introduction of the assisting-spring, the power of which increases as much as or more rapidly than the pull upon the solenoid-core decreases, not only accomplishes the same purpose, but also increases the possible length of traverse, notwithstanding the fact that the pull on the core due to the magnet alone becomes less and less as the core rises. The lamp herein described is thus able to draw a very long arc, if it be necessary to do this in order to cut down the current, but its normal regulation is accomplished with a very small change in in the current strength. In lamps containing this invention, furthermore, it is not necessary to employ a resistance in the lamp-circuit, as has heretofore been necessary with constant-potential alternating arc lamps, and thereby a very considerable gain in efficiency is secured. With the assisting-spring present, the arc is drawn to an abnormal length, and thus prevents the extraordinary flow or current, when the lamp is starting up with new carbons, due to the large amount of conducting-vapor, as already explained. The difficulty heretofore has been that the pull of the solenoid upon its core has not been powerful enough throughout its entire range of movement. It is amply sufficient in the lower position of the core, but too weak in its upper position.

The accompanying drawings show embodiments of the invention, wherein—

Figure 1 is a side elevation, partly broken away and partly diagrammatic, of my improved lamp. Figs. 2 and 3 are details. Figs. 4, 5, and 6 are modifications.

The construction of the lamp, outside of the particular improvements herein detailed, is described in application for Letters Patent, Serial No. 515,695, filed June 25, 1894, by myself and Elihu Thomson.

The frame supporting or carrying the wheelwork is pivoted at P and is rotatable about this pivot, carried in one direction by the weight of the parts and in the other by the attraction of the solenoid and the assisting-spring Z, attached at one end to the gear-supporting frame and at the other to the plate F. The shape of the plate F is best seen in Figs. 2 and 3, where my improvement is shown removed from the other parts of the lamp. This plate pivots on a knife-edge at P^2, the spring being attached in any convenient way to its outer end, as at O. When the solenoid-core K is in its lowest or unattracted position the spring Z is least effective in lifting the weight of the moving parts, because it occupies the position of the dotted line *d*, Fig. 2, and is pulling nearly in line with the pivot P, or "on a center," as commonly said; but as the core K is attracted and the power of the coil in lifting the weight of the moving parts decreases the spring Z gradually takes the position shown in full lines and becomes, therefore, increasingly effective.

The strength of the spring is made such and its point of attachment to the frame so arranged as to make the assisting force just the amount desired. That adjustment is of course made which tends to bring about and maintain the normal resistance of the arc or value of current. By thus decreasing the effective lifting power of the solenoid-core in its lowest position and supplying an assisting force as it is attracted it is possible to start the arc with much less than the normal current, as already pointed out, the current gradually rising until it attains the normal, or, if so desired, by proper adjustment the lamp will start with very nearly its normal current and regulate itself to maintain it.

Figs. 2 and 3 show detail views of the spring Z and its supports from the side and top respectively. The brass frame H is secured to the supporting-frame of the apparatus at P *p*. At one end is a stud, through which passes a threaded rod, a nut upon which permits the adjustment of the spring. At the other end a piece H′ is riveted to the frame H, and the plate F is bent at a right angle and is provided with a slot S, engaging with a pin I upon the core K. The plate F may be turned to the position shown in dotted lines at F′, Fig. 2, and may then be slipped out or in

through the slots. The spring Z is attached to the plate F at the point O.

Referring now to Figs. 4, 5, and 6, I show how my invention may be modified by various attachments of the spring Z and yet secure the same results of operation. In Fig. 4 the spring exerts an increasing force as it approaches the position of the dotted line, being carried by a bell-crank lever G and attached at *h* to the frame of the lamp and at the other end by its adjusting arrangements to the arm A of the bell-crank.

It will be seen that the lift of the core tends to throw the spring away from the center, against which it pulls, thus assisting the core in its rise, as already pointed out.

In Fig. 5 one end of the spring is attached to any stationary point—for instance, at *h* on the stationary arm X—and the other end is attached to the lever Q, to which the solenoid-core K is elastically connected, as in the application of Thomson and Harthan referred to. In this case the spring is brought to the position of the dotted line, and, as will be readily understood, becomes increasingly effective.

In Fig. 6 both ends of the spring are attached to moving parts, one end going to the end of the lever L, the other to the end of the lever L′. The lever L is pivoted at P^5 and the lever L′ at P^4. When the core K is attracted into the solenoid-coil, the free ends of both levers move down and the spring Z is given an increasing leverage, becoming more and more effective, it being understood that the effect of the increasing leverage is so arranged as to more than counterbalance any decrease in the power of the spring due to its contraction.

In Figs. 4 and 5 I have indicated the springs Z′ assisting to support or balance the weight of the solenoid-core, &c., as in my application already referred to. These form no part of the present invention, being merely auxiliary in their action so far as my present improvement is concerned. In the arrangement shown in Fig. 1 they may be dispensed with and the spring Z made to serve alone if desired.

So far as I am aware it is new to apply a spring progressively assisting the action of the actuating-magnet in an arc lamp, and the claims now to be made are to be construed broadly in this respect.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In an arc lamp, a coil, a core actuated by the coil, feeding mechanism for the lamp operated or controlled by the core, and a spring arranged to progressively assist the action of the core, substantially as described.

2. In an arc lamp, a coil, a core actuated thereby, feeding and arc-striking mechanism operated or controlled by the core, and a spring arranged to progressively assist the motion of the core, substantially as described.

3. In an alternating current arc lamp, the combination of the carbons and feeding mechanism with a magnet receiving alternating currents whose core controls the feeding mechanism, and a spring arranged to progressively assist the movement of the core, as set forth.

4. In an electric arc lamp, a series coil, a core actuated thereby, gearing for the lamp controlled by the core of the coil, a spring attached at one end to the stationary part of the lamp and at the other by suitable connections to the core, the spring being so arranged as to assist the lift of the core to a minimum amount at one end of the traverse and a maximum amount when the core is in its extreme attracted position, substantially as described.

5. In an electric arc lamp, a series coil, a core therefor, gearing carried in a frame pivoted in the lamp, one end of the frame being attached to the core, a spring attached to a stationary part of the frame, and a plate forming with the part of the frame to which the spring is attached a toggle mechanism, the spring being attached at its other end to the plate; whereby the lift of the core tends to bring the spring into a position where its pull will assist the core more and more as the core rises, substantially as set out herein.

6. In an electric arc lamp, a coil, a core actuated thereby, mechanism operating the lamp actuated by the coil, a spring arranged to assist the coil, as herein set out, the spring being attached at one end to a stationary part of the lamp and at its other to a lever connected to the core, and adapted by the motion of the core to bring the spring into a position of greater activity in assisting its action, substantially as described.

In witness whereof I have hereunto set my hand this 19th day of November, 1894.

CHARLES E. HARTHAN.

Witnesses:
JOHN W. GIBBONEY,
HENRY C. WESTENDARP.