(No Model.)

A. G. WATERHOUSE.

ELECTRIC LIGHTING SYSTEM.

No. 505,241. Patented Sept. 19, 1893.

Fig. 1

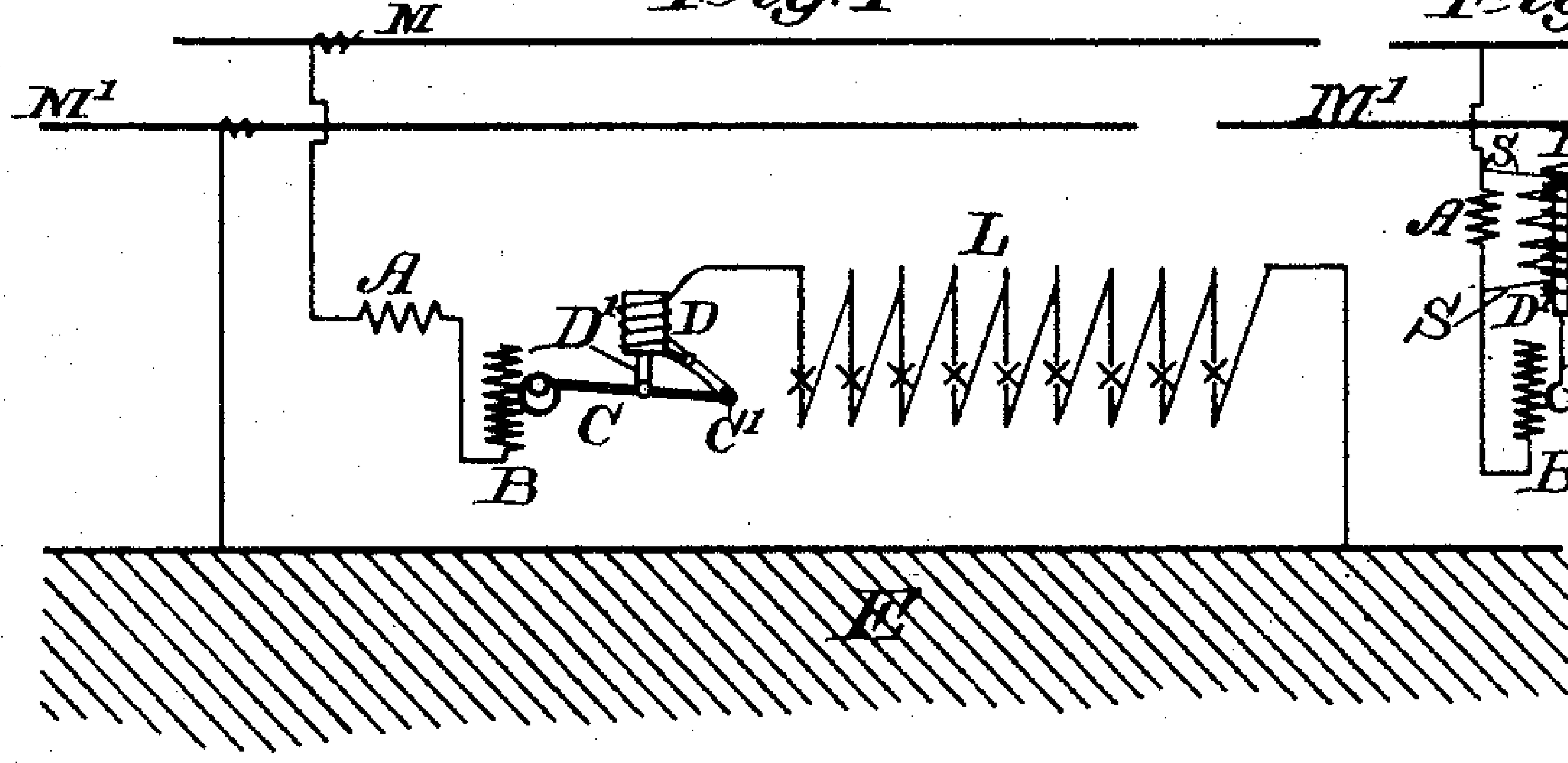


Fig. 2

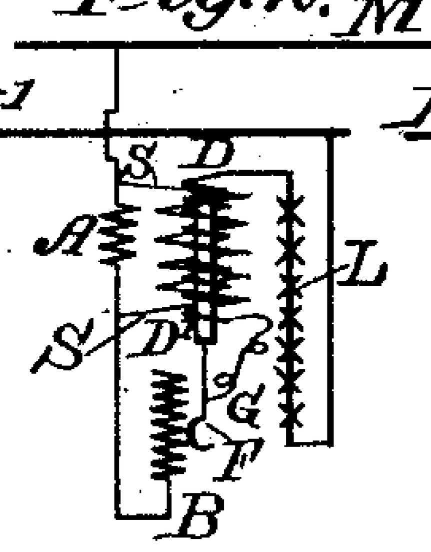


Fig. 3

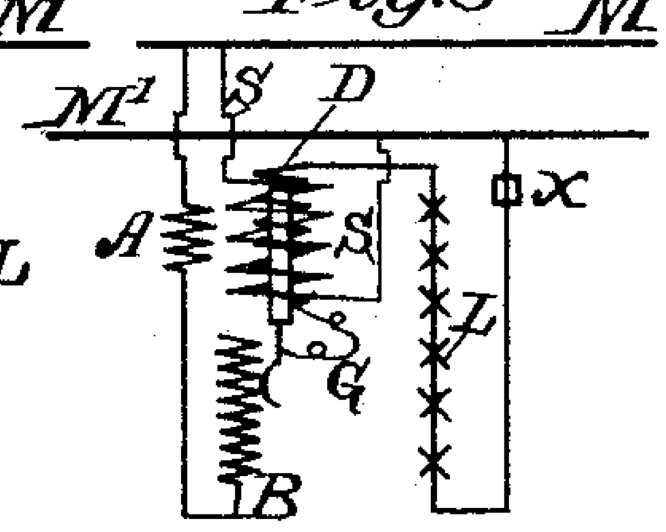


Fig. 4

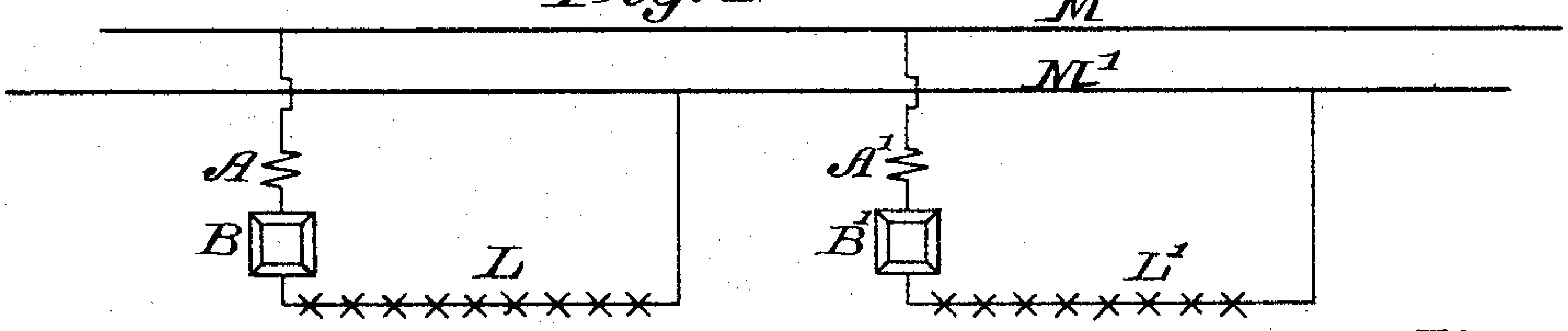
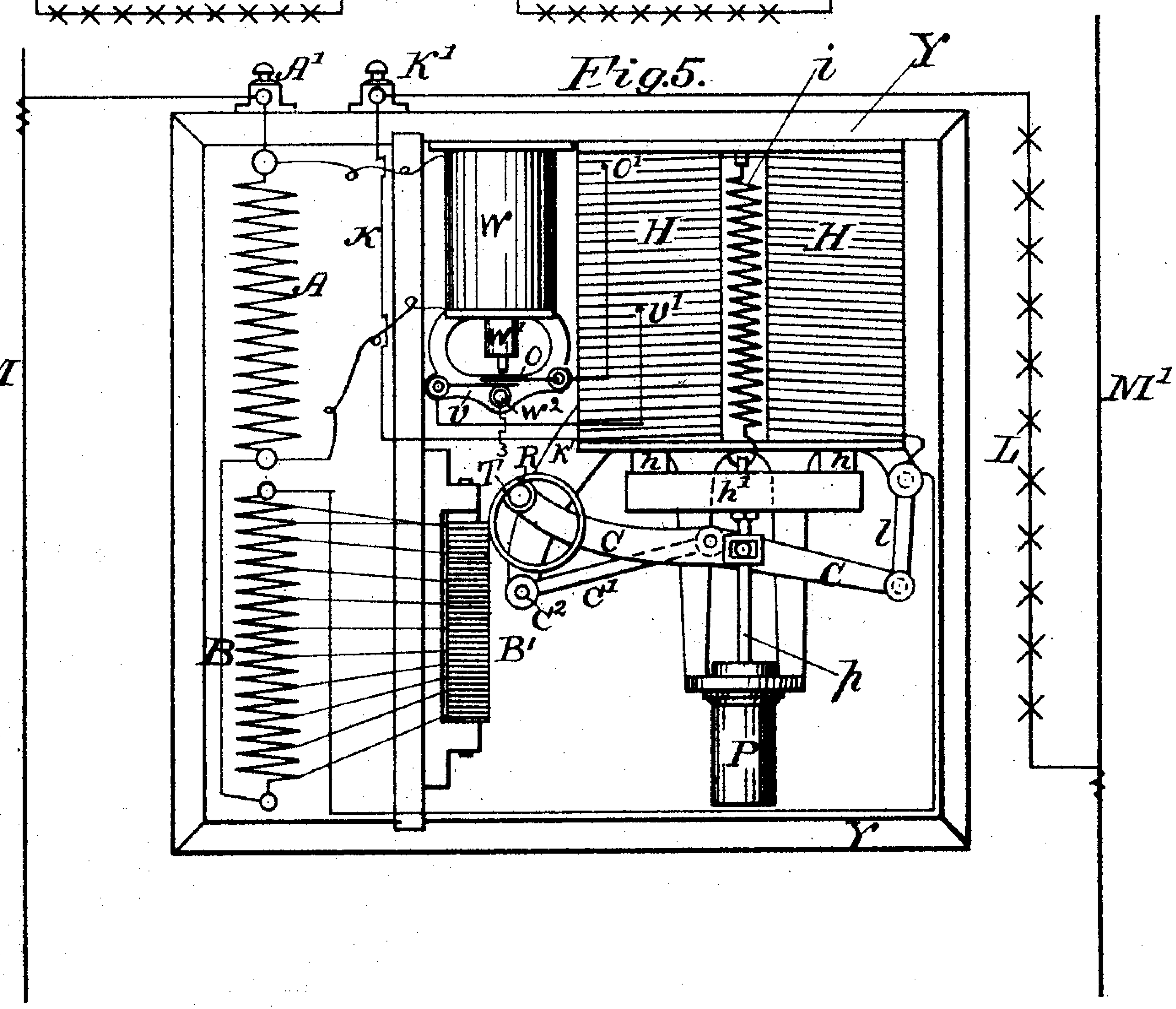


Fig. 5.



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ADDISON G. WATERHOUSE, OF HARTFORD, CONNECTICUT.

ELECTRIC-LIGHTING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 505,241, dated September 19, 1893.

Application filed November 28, 1892. Serial No. 453,313. (No model.)

To all whom it may concern:

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, residing in the city of Hartford, in the State of Connecticut, have invented new and useful Improvements in Electric-Current Regulating Devices, of which the following is a specification, reference being had to the accompanying drawings, making a part thereof.

The primary object of my invention is to create a system of burning electric arc lights in series, upon street car circuits, or lines having a comparatively high electro-motive force, and a voltage that is constant within certain limits.

The object to be attained and the conditions to be met, I will suppose to be as follows: To burn as many arc lamps as can be run in a series, across the two opposite lines of street car, or other, circuits which have five hundred volts electro-motive force, and a variation, owing to the changes of load, or other causes, of one hundred volts; or, in other words, a line having a maximum voltage of five hundred volts and a minimum voltage of four hundred volts. The lamps will require a constant current of eight ampères, and each will have a voltage of forty-three volts, so that nine lamps in a series would require a voltage of nine by forty-five volts, or three hundred and eighty-seven volts. Therefore, I place in series with the lamps, a constant resistance which will require thirteen volts for the current to overcome. These thirteen volts added to the three hundred and eighty-seven lamp volts, make four hundred volts, which equal the minimum electro-motive force of the line. In addition to the fixed resistance, I place an automatic shifting resistance, or rheostat, capable of throwing in the line an extra voltage sufficient to overcome any excess of electro-motive force which may occur on the line, up to the maximum electro-motive force of five hundred volts. The method of arranging these resistances in circuit with the lamps, together with the manner of constructing and operating the same, will be hereinafter described.

In the accompanying drawings: Figure 1, shows a combination of a fixed resistance or a rheostat, and a shifting resistance placed upon a street car circuit. Figs. 2, and 3, show modified forms of Fig. 1. Fig. 4, shows two series of lights with their respective resistances placed upon the same circuit. Fig. 5, is an enlarged view of the automatic resistance working device.

Fig. 1, shows two main lines representing the source of energy. Line M, is supposed to be the over-head or trolley wire, while line M′, is grounded to the earth, E, so that between M and E there is supposed to be an electro-motive force, varying from four hundred to five hundred volts. Connected to the line M, is a circuit, upon which is placed a fixed resistance, A, and an automatic rheostat worked by the electro-magnet D, in response to current changes in line. In series with the resistance A, and rheostat, composed of resistance B, contact lever C and actuating magnet D, is a series of lamps L, which form part of the circuit on its way to the earth, E. The operation of this device is as follows: We will say the magnet D, is wound so as to draw up its armature D′, and with it, the contact lever C, when the current rises above eight ampères, and to lower the armature and lever C, when the current falls below eight ampères. The course of the current is upward, through the changeable resistance B, so that if the current tends to rise above eight ampères, the lever C, is swung up and the current has to pass through a greater length of the resistance B, this being so proportioned that it would reduce the current to eight ampères when the movement of the lever C, would stop; and, in case the current should fall below eight ampères the magnet D, would be weakened, and the lever C, would swing down, shortening its contact with B, and reducing its resistance so that the drop of current below eight ampères, would be checked. It is plain that, as shown, the changes in the current passing through the lamps on this circuit would act upon the magnet D, and vary the position of the lever C, thereby changing the resistance offered by the resistance coil B, in a way adapted to counteract such current changes, and keep the current nearly at a fixed standard. It is also plain, that in this device the current must rise above a certain standard, say eight ampères, to draw up the lever C, and increase the resistance enough to prevent the increase of current; and also, the current must fall below the eight ampères, in order to cause the lever C, to fall and shorten the resistance for the purpose of checking the decrease of current. This fact, will show that certain variations of the current must be permitted, in order to check extreme changes and such necessary variation would be objectionable, as they would cause constant undulations in the lighting effect of such current, and cause the rheostat to keep in constant motion, a defect in its action, which is called, seeking. In order to remedy this defect, I resort to other means; one of which is shown in Fig. 2, in which a circuit is shown extending from one main M, to the other M′. Either of these lines may be represented by the earth, by being grounded. In this case, the circuit starts from line M, forming the fixed resistance A, then forms the part of the resistance coil B, extending from its lower end to the point where the slide F, contacts; then from F, out through a flexible wire G, and then through a coiled conductor, forming part of the magnet D; then through the lamps L, or any form of translating devices, to the main wire M′. So far, this device is similar to that shown in Fig. 1. The improvement embodied in this form, consists of the derived circuit S. S., which spans the fixed resistance A; this derived circuit forms a coil around the magnet D, which acts as an auxiliary to the main circuit coil, as described. The purpose of this derived circuit S. S., is to multiply the magnetic effect of current changes on the magnet D, by increasing the sensitiveness, which is effected as follows: Any current changes acting through the main of the lamp circuits, will tend to alter the strength of magnet D, and move the contact E, on the resistance coil B, the same as described in referring to Fig. 1. In addition to this work performed by the main current, any changes in the main current will cause a corresponding change in the voltage offered between the two extremes of the fixed resistance A, and this change in voltage will produce a corresponding change in the current which passes around through the shunt coil of magnet D, in a way to multiply the sensitiveness of the magnet D, and reduce its seeking, or variation, from a fixed standard within objectionable limits. Another point of advantage in using the auxiliary shunt coil on the magnet D, is that in case any of the lamps should be cut out, or any part of the working circuit should be short circuited, then the current, increasing, would cause the magnet D, to increase the resistance in B, and hold the contact at a higher point, then, after the current fell, to its normal standard. The shunt coil would vary in a way to regulate the position of the contact, the same as if no changes had occurred on the working circuit, and, in a measure, the function of the main circuit part of the magnet D, will be to throw in a compensating resistance, to re-establish any changes in the resistance on the working circuit; while the function of the shunt part of the coil of magnet D, will be to oppose any variations in the current passing on the line; at the same time, they mutually assist each other in performing both duties.

Fig. 3, shows a further modification in the use of a derived circuit coil, in actuating the regulating magnet B. This figure shows the same form and arrangement of parts, as shown in Fig. 2, varying only in the connections of the derived circuit forming part of the magnet D. In this case the shunt, or derived circuit S, extends from one pole to the other of the main conductors, and takes the total electro-motive force, of the main circuit. The advantage of this combination becomes obvious by considering the advantages set forth in referring to Fig. 2. It is plain, that if the main current part of magnet D, performs its work in throwing in any resistance required on account of changes in the resistance of the lamp circuit, then, after it has reduced the current to its normal volume, any changes in the current must be due to changes in the voltage between the mains M, and M′, and such changes in the voltage would cause the derived circuit, which forms part of the magnet D, to move in a way to shift the contact on resistance B, so as to maintain a constant current in the lamp circuit. This shifting of the resistance would be performed by changes in the voltage between the main M, and M′, and would not depend upon any changes in the current of the lamp circuit; therefore, the lamp circuit could be maintained constant, by the action of the changes in the main circuit voltage. In the above cases I have shown the derived circuit used upon the same magnet as the lamp circuit current, and also used for aiding the strength of the lamp circuit magnet. But, it is to be understood that both, the derived and the lamp circuit magnets, may be used so as to have a differential action; that is, one will, to an extent, oppose or counteract the effect of the other, so that each circuit can have separate magnets, and the same be mechanically hitched together, so as to aid or counteract each other's motion in any way adapted for the purpose to which they are applied; that the resistant force of the two circuits will shift a resistance placed on the line, in order that a constant current will be maintained, when either the resistance of the lamp circuit, or the voltage of the main source of energy, is changing. It is also understood that the lamps placed in circuit, are to be provided with an automatic switch, which, when the lamps burn out, or are cut out, will introduce an equivalent resistance in the line; or a switch which will short circuit each lamp at its cut out, and, in such case, the automatic resistance B, must have capacity enough to throw in a compensating resistance, in place of any loss of resistance on the line, and in case the lamp circuit should become so shortened in resistance, that the automatic resistance could not oppose its building up, I place in the line a fusible plug x, or any form of circuit breaking device, which will break the lamp circuit in case of a certain excess of current.

Fig. 4, shows a system of lighting from a street car circuit whereby two or more series of lights, or translating devices, may be had from the same source of power, each series being provided with similar means for regulating the current as heretofore described.

Fig. 5, shows an enlarged view of one form of resistance working device, consisting of an external case Y, which incloses the mechanism, consisting of double electro-magnet H, having a two bar armature h, h provided with a horizontal yoke H′. This armature is adapted for being drawn up into the magnet coils H. H., with a force depending upon the energizing current. To assist the magnets in raising the armature, I use a spiral spring i. The downward motion of the armature is produced by gravitation. In order to prevent a too rapid motion of the armature, I provide it with a dash pot P, the plunger of which is connected to the armature of the rod p. Pivoted to the frame holding the magnets H. H., by means of a swinging link l, is a tilting lever C, which has pivoted at its center, a swinging rod C′, which is pivoted at the other end of the frame, holding the magnets at C^2. The object of this rod C′, is to produce a parallel motion to left end of the lever C, so that as it swings up and down its left end will move parallel to the series of contact plates B′. On a horizontal pin R, made a part of the lever C, is hung one or more loose copper rings T, which rest on the pin R, and swing against the faces of the contact plates B′. Therefore, as the lever is swung up and down, the rings T, move on the plates forming the series B′, and change their points of contact. The lever C, is pivoted near its center to the dash pot rod p, which is made a part of the armature yoke H′, so that as the armature is drawn up, by the action of the current in the magnetic coils, the lever C, and rings T, move up with it; while the downward motion of the moving parts is caused by gravitation. The electric routes are similar to those shown in the previous figures, that is, the current from main wire M, on entering at terminal A′, passes through the fixed resistance A, then down a side wire to the lower end of the changeable resistance B, and up through more or less of the resistance B, to the leading wire extending from B, to the plate of the series B′, against which the rings T, contacts. Therefore it is plain that the position of the ring would fix the resistance, which the coil B, would offer to the current. As shown, the current would have to pass through all of the coil B, which would offer its greatest resistance. If the ring moved down, less of the coil B, would have to be traveled, and the resistance would be proportionally less, so that the route of the current, after reaching the ring T, passes along the lever C, to the frame holding the magnet coils H. H., then, through the coils and out on wire K, to terminal K′; then to the lamps L, and on to the main wire M′, so, that any current changes would affect the magnet H, in a way to impart motion to its armature, and through it, to the lever C, and ring T, in a way to change the resistance offered to the current, by the coil B, for the purpose of regulating such current, as before described. In this case I have made use of a controlling magnet, consisting of an electro-magnet W, adapted to work a movable armature W′, upward by its attractive force, and allow it to move down by gravitation. Below the armature W′, is a spring contact plate O, which is electrically connected to the conductor of the magnet H, at O′. Under the spring O, is a second contact spring V, electrically connected to the conductor of magnet H, at V′. Under the spring V, is a contact pin W^2, electrically connected to the conductor, after it leaves magnet H, as shown when the current, which actuates the controlling magnet M, is strong enough to raise the armature N′, from the contact spring O. The springs O, and V, are separated from the pin W^2, but, when the current weakens, the armature W, falls and forces the spring O, against the spring V, and thereby short circuiting the part of magnet H, between the points O′, and V′, and if the current still weakens, the armature W′, still falling presses the springs O, and V, down, so as to cause V, to contact with the pin W^2. This would short circuit magnet H, from O′, to V′, and from V′, to the end of its coil. The purpose of the above is obvious. When the armature W′, is up the current is strong. This gives the full force to the magnet H, and causes it to rise and cut in the resistance B. After doing so, it reduces the current, so that the armature W, will fall a little and short circuit a small part of the magnet H, just enough to dull its action, but not enough to cause it to fall. This stops its movement and prevents what I call seeking. Now, in case the current continues to fall, the armature W′, presses the spring V, down on point W, and cuts out a larger part of the magnet H, and this, reducing the strength of magnet H, causes it to allow the lever C, to swing down and cut out part of the resistance B, until the current again rises to the standard. In that way, the magnet W, increases the strength of magnet H, when it would move upward, and partly cripples magnet H, so that it will remain stationary when the current is at its proper standard; and weakens the magnet H, so as to cause it to move downward quickly when the current weakens. It is plain that the magnet W, can be wound by a derived circuit, connected, either, as shown in Figs. 2, or 3, or by the current conductors, the same as magnet H. The magnet H, can be wound by both the lamps and a derived circuit, as shown in Figs. 2, and 3, or separate magnets, wound by the lamp and a shunt circuit, can be used to operate the lever C.

In using the derived circuit and the lamp circuit differentially, it will simply be necessary for the magnet strength of one to predominate over the other, and cause the work of shifting the resistance of coil B, by means of the predominating strength of one over the other. It will also be possible, in some cases, to work the resistance B, entirely by means of the magnetic effect of a derived circuit connected in either of the ways above shown.

What I claim to be my invention is—

1. In a system of electric lighting, consisting of a path crossing from one main line to the other, representing the positive and negative sources of power, the combination with one or more electric lights, or translating devices, of an automatic rheostat actuated by both the magnetic forces of the current which passes through the lamps, and the current of a derived circuit which spans the whole or part of the path upon which the lamp or lamps are placed, substantially as and for the purposes set forth.

2. An automatic rheostat consisting of the working magnets H, and a swinging contact lever C, having a parallel motion of the contacting end; substantially as and for the purpose set forth.

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