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W. E. SAWYER & A. MAN.
Electric-Lighting System.

No. 205,303. Patented June 25, 1878.

Fig. 1.

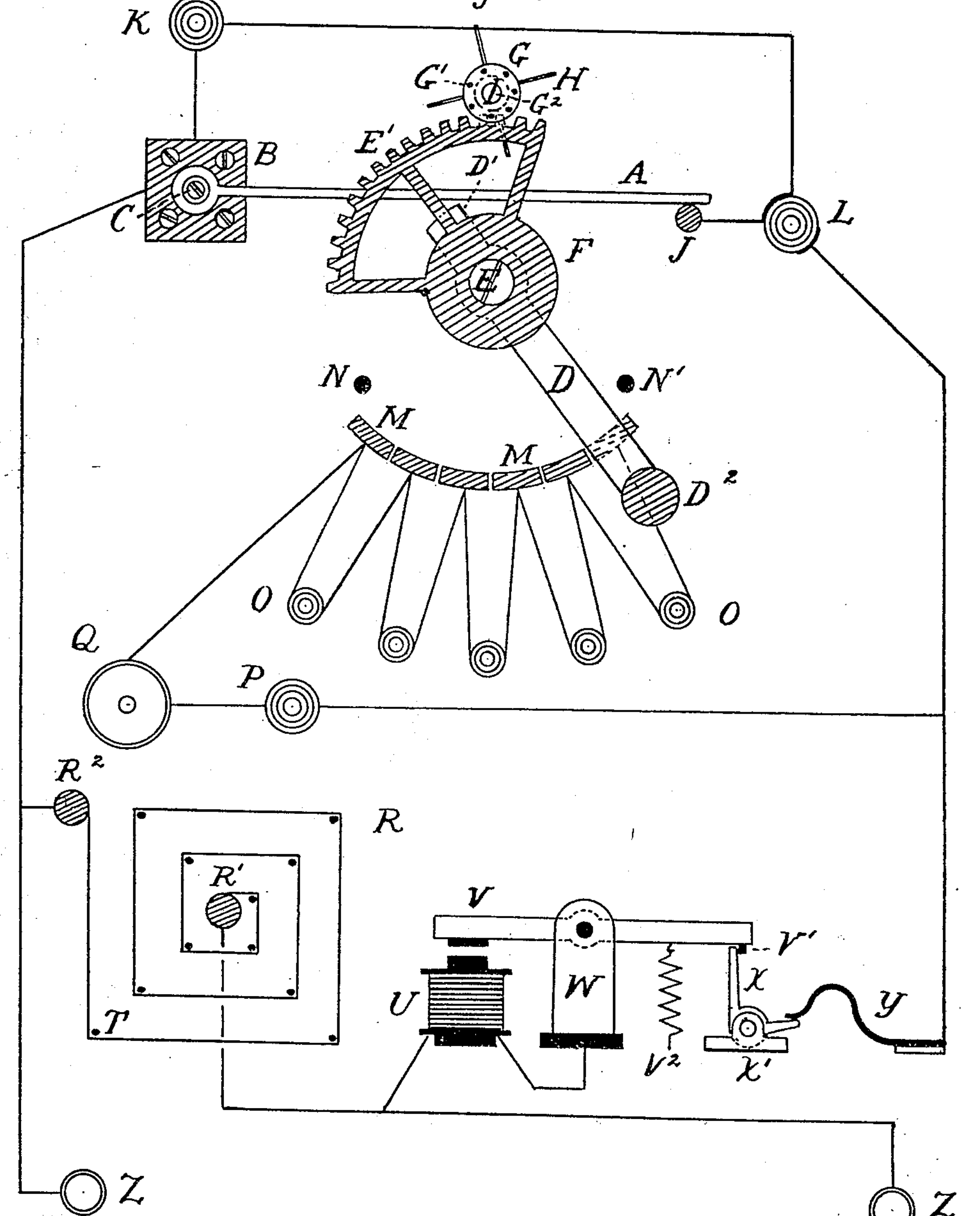

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Fig. 2.

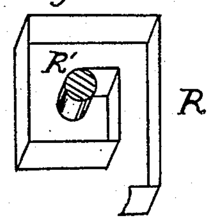


Fig. 3.

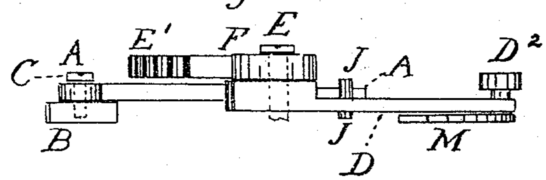


Fig. 4.

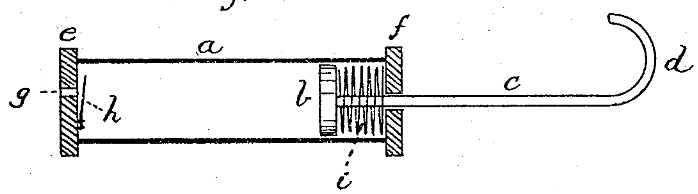
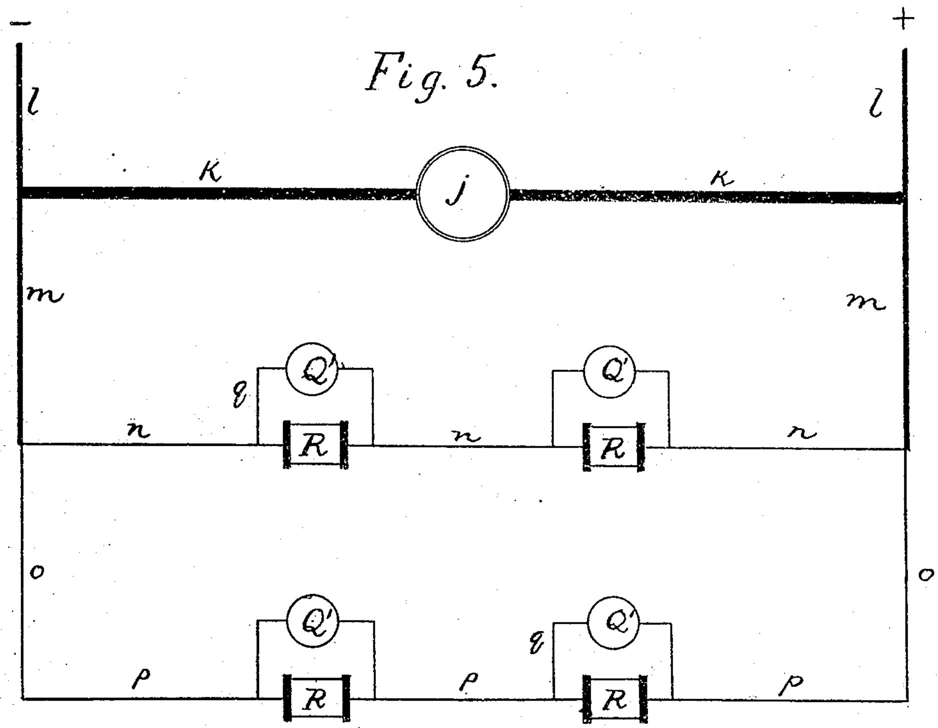


Fig. 5.



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UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, OF NEW YORK, AND ALBON MAN, OF BROOKLYN, N. Y.

ELECTRIC-LIGHTING SYSTEM.

Specification forming part of Letters Patent No. **205,303**, dated June 25, 1878; application filed May 31, 1878.

To all whom it may concern:

Be it known that we, WILLIAM EDWARD SAWYER, of the city, county, and State of New York, and ALBON MAN, of the city of Brooklyn, county of Kings, and State of New York, have jointly invented certain new and useful Improvements in Electric-Lighting Systems, of which the following is a full, clear, and exact description.

In another application filed by us we have shown and described an electric lamp in which light is produced without consumption of the carbon producing it.

The object of our present invention is to provide for such a distribution and application of the electric current as will render our own or any other lamp practically operative upon an extensive scale.

Our system consists in (first) a new arrangement of electrical circuits, which are in part (second) composed of conductors diminishing in transverse mass as they increase in length, and in part (third) of conductors having great radiating-surface, provided with (fourth) safety-switches to guard against the dangers of short-circuiting in connection with (fifth) lamps and lamp-lighting devices, by means of which the lamps are lighted and extinguished without danger of fracturing the carbons thereof, or of interrupting or changing the resistances of the circuits.

In the drawings accompanying and forming a part of this specification, Figure 1 is a general view of the arrangements at each lamp, including a top view of the lamp-lighter and a side view of the safety-switch. Figs. 2 and 3 are other views of parts of Fig. 1, and in Fig. 4 is outlined a modification which may be made of a part of the lamp-lighter. Fig. 5 is a diagram of the circuits, showing the combination of several of the sets of apparatus shown in Fig. 1.

Referring, first, for convenience of description to Fig. 5, *j* is a generator of electricity supplying the outletting conduits or conductors *k k*, which branch into conductors *l l m m*, the continuations of which are shown only in the case of conductors *m m*, the circuits of conductors *l l* being merely indicated by the + and — signs. There may be any number of branches *l l m m* leading from the outletting-conduits according to the volume of current supplied by the generator *j*. The outletting-conduits *k k*, as indicated by the thickness of the lines, are large, in order, without heating and consequent waste, to conduct the great quantity of current supplied. It is clear that all the conductors may be of uniform size; but the expense of such, as against conductors diminishing in transverse mass as they extend outward, is so considerable that we have adopted the latter plan. Therefore we make the first sections, *m m*, of the circuits smaller than the outletting-conduits, and the next sections, *o o*, still smaller, and so on indefinitely. In the cross-branches *n* and *p* in circuits *q q*, derived by means of resistances R R, we place the electric-lighting apparatus of our invention, Q'.

Referring now to Figs. 1, 2, and 3, Q is the lamp; A D M, the lamp-lighter; U V X, the safety-switch, and R the resistance. (Shown in Fig. 5.)

In the lamp of our invention hereinbefore mentioned, which we prefer in all cases to employ, a small piece of carbon is heated to incandescence in an atmosphere with which it will not chemically combine. Other attempts to produce such a lamp have been made, but among other things it has been found almost impossible to prevent fracture of the carbon. The fracturing of the carbon is mainly due to sudden changes in temperatures. While it becomes soft and pliable under the heat of the current at ordinary temperatures, it is extremely brittle, and instantaneous heating from its normal condition to a temperature of from 5,000° to 10,000° Fahrenheit tends to disrupt the particles and establish the voltaic arc by which in a moment the carbon is destroyed. The lamp-lighter avoids this difficulty. Again, an accidental short circuit may occur with the result of supplying so much current to the lamp as to volatilize or destroy the carbon unless instantly and automatically checked, and this danger is provided against by the safety-switch. To avoid undue electrical heating from accidental or other causes in the conductors, and the great resistance occasioned by the heating of a conductor, especially when in the form of a rheostat, we construct our artificial circuits, rheostats, or resistances R, of flat or ribbon wire, in order that they may present considerable radiating-surface, and thereby keep cool when otherwise they might be melted by the electric heat.

The connectors Z Z of Fig. 1 indicate the points at which the lighting-circuits leave the branches *n* and *p* of Fig. 5.

A is a flat metallic spring-lever fixed to holder B by screw C, and making connections, when the lamp Q is not in circuit, with contact-point J.

D is a lever provided with finger-piece D^2, working on screw or stud E. When the lever D is in the position shown, its rounded extremity D′ is clear of spring-lever A; but when moved to the left the end D′ makes connection with the spring-lever and simultaneously lifts the latter from its connection with contact-point J.

Fixed to the lever D is a mutilated spur-wheel F, the teeth E′ of which mesh into the pins G′ of pinion G. The pinion G, rotating on screw or stud G^2, carries with it a fan, H, situated below the pinion; but as the construction of such mechanism is thoroughly understood, we have not deemed it necessary to illustrate the same in detail. The object of the fan is to retard the movements of the lever D, and thus compel the person lighting a lamp to "turn on" the current gradually. Any other means of insuring a gradual movement of the mechanism will answer the purpose; and, as an example, we have indicated in Fig. 4 a modification that may be made in this apparatus, *a* being a tube of glass or metal, in which travels a plunger, *b*, on piston-rod *c*, provided with finger-hook *d*. The piston-rod works loosely in the tube-head *f*, and the plunger is pressed toward tube-head *e* by coiled spring *i*. In the head *e* is an opening, *g*, provided with a valve, *h*. This device may be attached to the apparatus of Fig. 1, so that, for instance, when the plunger is drawn into the position shown, a catch shall take hold of the lever D, and the piston-rod being released and the valve *h* closing, the slow escape of the air as the plunger is followed up by spring *i* may cause the piston-rod to slowly move the lever D and light the lamp. The piston-rod *c* disengaging when the lamp is lighted, all that is necessary in order to put out the light is to move the lever D back to the position it occupies in Fig. 1, and this may be arranged to be accomplished by a second catch upon the piston-rod *c*, and the same movement of the rod as that which takes place upon lighting the lamp; but since, as before observed, any retarding device will answer the purpose, we have not deemed it necessary to enter into the details of modifications, which would only needlessly cumber our specification.

Recurring to Fig. 1, K and L are resistances of, say, fifteen ohms each. P is a resistance of, say, twenty ohms; and O O are five resistances of, say, two ohms each. N and N′ are stops for lever D. M M are six metallic contact-pieces, with which lever D makes connection as it is moved, which contact-pieces are connected, as shown, with the five resistances O O. All of these resistances may be of the character of resistances R, which, as better shown in Fig. 2, is a flat wire or ribbon of metal. This ribbon is wound over pins T, fixed to any suitable insulating-base. The connectors R R′ may be of any desired form. Being in the shape of a ribbon, the conductor constituting the resistance has a large radiating-surface, and a space being left between each layer to permit of free access of air any heat which may be evolved is rapidly dissipated. The resistance R operates to divert a portion of the current flowing in the branches into the lamp Q. In many cases it may be omitted.

The safety-switch is of the simplest construction. U is an ordinary electro-magnet; V, an ordinary armature-lever; W, a standard, in which the armature-lever is pivoted, and V^2 a retractile spring. The pin V′, fixed to the lever V when the lever is not actuated by the magnet U, serves to hold the bent lever X, working in its bearing X′, in the position shown in the drawings. When, however, the lever V is attracted by magnet U, the pin V′ is lifted and the lever X, actuated by spring Y, escapes from its imprisonment.

The operation of the switch is as follows: When the proper strength of current is supplied to the lighting-circuit, the spring V^2 is so adjusted that the lever V does not respond to magnet U; but when from any cause there is an increase in the current which might injure the lamp or other apparatus or other lamps in circuit, the retractile force of the spring V^2 is overcome by the attractive force of the magnet, and the circuit through spring Y, lever X, armature-lever V, standard W, and the magnet is instantly broken by the release of lever X.

In place of the safety-switch we may interpose in the circuit a section of a conductor more readily fused than the conductors constituting the rest of the circuit, so that when there is too much current this section shall be instantly melted and the continuity of the circuit destroyed.

The operation of our apparatus is as follows: The current enters the resistance R from the points Z Z. From the resistance at the points R′ and R^2 the current divides, the required portion entering the lighting-circuit. When the lever D is in the position shown, the current passes from the point R^2 to the spring-lever A, contact-point J, resistance L of fifteen ohms, and thence through spring Y, levers X and V, standard W, and magnet U to the point R′. In this position of the lever D the lamp is not in operation, and the resistance of the circuit is fifteen ohms, (disregarding everything excepting resistance L.) To light the lamp, the lever D is moved to the left, and while it is still in connection with the first contract-point, M, its end D′ makes connection with spring-lever A, and the connection between A and J is broken. Without having been interrupted the circuit of the lighting apparatus is now divided into two sub-circuits, one of which is from the point R^2 by way of spring-lever A, resistance K, of fifteen ohms, resistance L, of fifteen ohms, and the safety-switch, to point R; total resistance of the sub-circuit thirty ohms. The other sub-circuit is from the point R^2 by way of spring-lever A, lever D, the first contact-point M, the five resistances O O, of two ohms each, the lamp Q, resistance P, of twenty ohms, and the safety-switch to point R; total resistance thirty ohms the resistance of the lamp while the carbon is cool being practically *nil*. The lighting-circuit being now divided into two sub-circuits of thirty ohms resistance each, the resistance of the circuit is still fifteen ohms, and although the lamp has been introduced, no disturbing influence has been exerted upon other lamps or circuits. The current flowing through the lamp begins to heat the carbon, which rapidly acquires resistance, and the resistance of the carbon increases in proportion to the movement of the lever D over the contact-points M until all of the five resistances O, of two ohms each, have been cut out of circuit, and the lamp is left in circuit with the resistance P, of twenty ohms; but the resistance of the lamp is now ten ohms, so that the total resistance of the sub-circuit of the lamp is still thirty ohms, and, the resistance of the other sub-circuit remaining unchanged, the joint resistance is as at the outset fifteen ohms.

It will thus be seen that the lamp-lighter of our invention not only prevents the too sudden heating of the carbon, but completely obviates the disturbing influences of changes in resistance which have heretofore accompanied the lighting or extinguishing of a lamp.

The application of the lamp-lighter to electric lamps in which the light is produced by the voltaic arc by removing resistances from the circuit in proportion as the carbons separate will be comprehended without further explanation.

Recurring now to Fig. 5, in which we have shown more than one branch from a single source of electricity, and more than one lamp in each branch, we are aware that it is not new to place a number of lamps in series in the circuit of a generator, or to divide the current among several conductors, each containing a single lamp, or to divide the current among several cross-branches, *n p*, each containing a single lamp. It is new, with us, however, to divide the current among several conductors, or several cross-branches, each containing two or more lamps, and lest the advantages of our arrangement may not be apparent we will proceed to explain the same in detail.

It is well understood, first, that to produce a good electric light a current of electricity combining considerable intensity is indispensable; second, in dividing the electric current among a large number of lamps, if there is a conductor from the generator to each lamp, or a cross-branch to each lamp, the quantity of current supplied must be very great, and in the event of a short circuit occurring in any lamp the result would be disastrous to the lamp, if it would not extinguish all the other lamps; third, in placing a large number of lamps in series, each lamp having a considerable resistance, the intensity of the current, in order to overcome the combined resistances, must be very great, and to obtain the proper current is far more expensive than it is to obtain a current of greater quantity with less intensity.

To illustrate the disadvantages attending the placing of very many lamps in series, let it be assumed that there are one hundred lamps in circuit, and that the resistance of each lamp is ten ohms, then the combined resistance of all the lamps is one thousand ohms, and this in the service of current for electric lighting is impractical. Suppose, now, that there are one hundred conductors leading from the generator, and that in each conductor there is a single lamp of ten ohms resistance, then the joint resistance of the one hundred lamps is the tenth of an ohm. Not to mention the wear and tear upon the generator of so slight a resistance, let it be supposed that a short circuit occurs in one of the lamps—as, for instance, by an accidental connection across the terminals of the resistances K, L, and P, thus cutting out those resistances—then the resistance of its conductor becomes *nil*, and not only are all the other lamps deprived of the current, or the greater portion thereof, but the short-circuiting lamp circuit receives so much current that the lamp is destroyed, even should there be no other disastrous result. If to avoid this we increase the resistance of the conductors, artificially or otherwise, outside of the lamps, we simply waste current in overcoming the added or artificial resistances which clearly would be costly, and consequently impractical. Adopting, finally, our plan, let it be supposed that there are ten conductors or cross-branches, *n p*, leading from the generator, each containing ten lamps of ten ohms resistance each. The combined and joint resistance of the circuit of the generator is ten ohms :—$\frac{10 \times 10}{10} = 10$. The resistance of the circuit is better suited to the generator, and should a lamp short-circuit the result would not be disastrous. On the contrary, it could hardly be detected. The very slight proportion of current taken from the ninety lamps in the nine perfect conductors, and the very slight proportion of current added to the nine lamps in the conductor containing the short-circuiting lamp would have no appreciable effect upon either the ninety or nine.

In concluding the description of the system of our invention we remark, first, that there may be in each lamp-lighter any number of resistances O, of any number of ohms, or parts of an ohm, resistance each; second, that the lever D may further operate to cut out resistances K and L, and, finally, to break their circuit altogether, reducing, while doing so, the resistance of the circuit of lamp Q; third, that everything in the lamp-lighter, excepting the the lever D, resistances O O, and lamp Q, may be omitted, since the resistances O O may be be increased to such an extent that when they are all in circuit the current will be too weak to heat the carbon, and removing them from the circuit will add resistance to the carbon by its heating in proportion as they are removed.

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

1. The combination, with an electric lamp, of a switch, which in lighting the lamp gradually removes a resistance from the circuit thereof.

2. The combination, with an electric lamp, of a switch, which, while preserving the continuity of the circuit, gradually removes a resistance from the circuit of the lamp.

3. The combination, with an electric lamp, of a resistance in the circut thereof which is lessened as the resistance of the lamp is increased.

4. The herein-descried method of lighting an electric lamp, consisting in causing the flow of current in such lamp to increase in strength slowly.

5. In an electric-lighting system, two or more conductors supplied with electricity by the generator of electricity which is the common source of supply for such system, and in each of these conductors, or in circuits derived therefrom, two or more electric lamps, the same being so arranged for the purpose of insuring the necessary distribution and subdivision of the current without artificial lengthening of the circuits by the introduction of resistances which would only waste the current, as set forth.

6. In an electric-lighting system, rheostats, resistances, &c., having great radiating-surfaces, the same being preferably constructed of a thin flat conducting medium, to which the air is given free access, so that the heat generated by the current is rapidly radiated or conducted off.

7. In an electric-lighting system, an electrical apparatus energized by the current flowing in such system, which, when there is an abnormal flow of current in a part or parts of such system, automatically operates to disrupt, disconnect, or change the circuit of such part or parts.

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