(No Model.) 2 Sheets—Sheet 1.

E. W. RICE, Jr.

DISTRIBUTING APPLIANCE FOR ELECTRIC LIGHTING SYSTEMS.

No. 354,233. Patented Dec. 14, 1886.

Fig. 1.

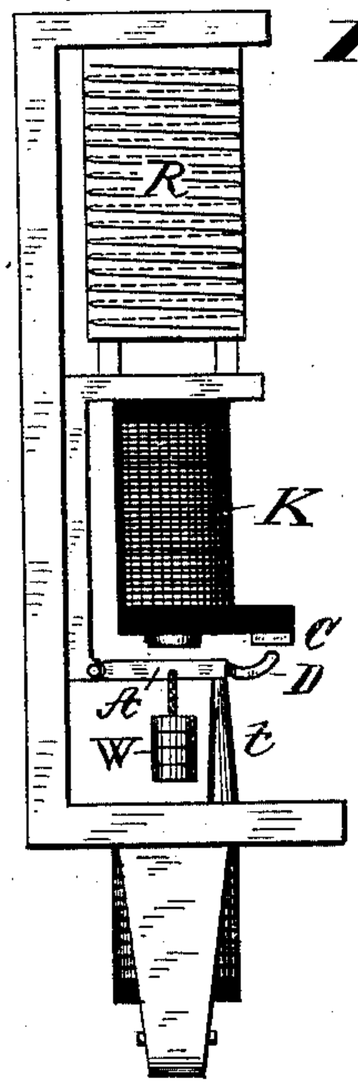


Fig. 2.

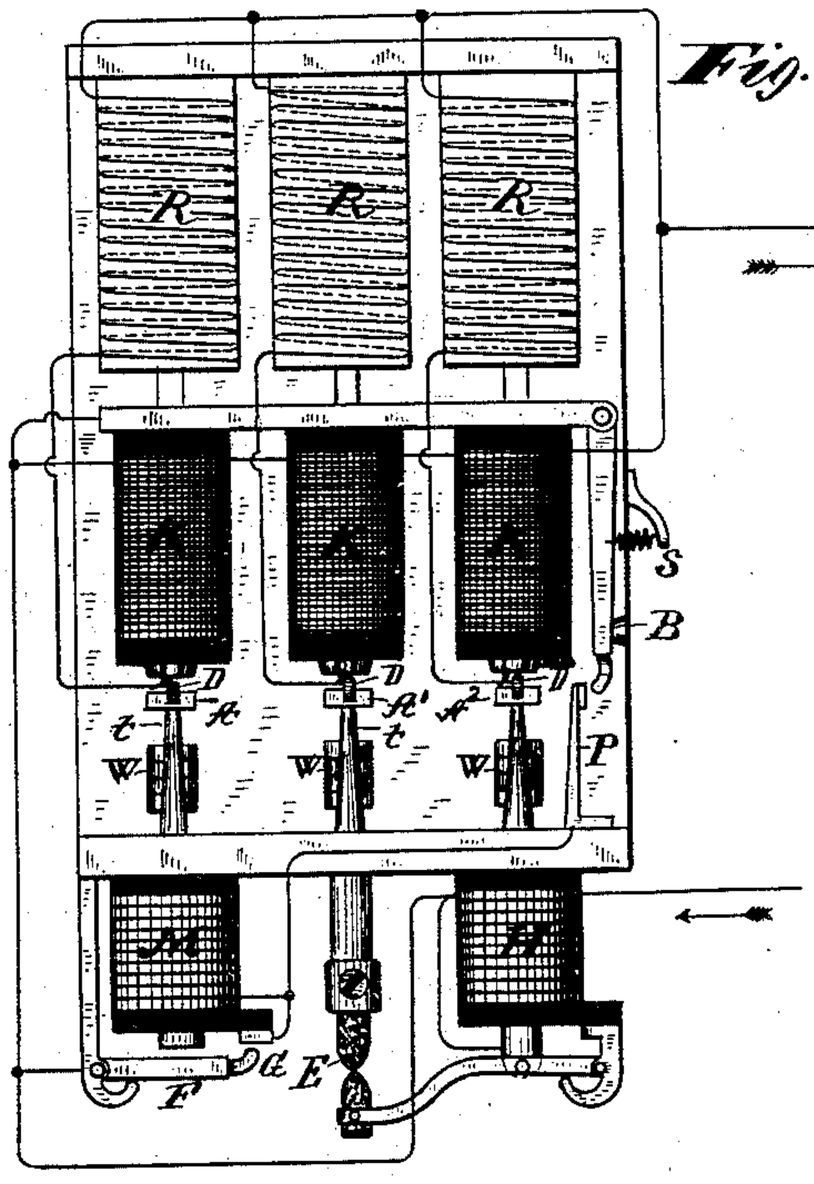


Fig. 4

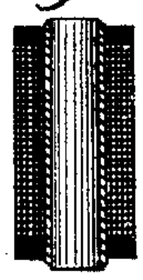


Fig. 5.

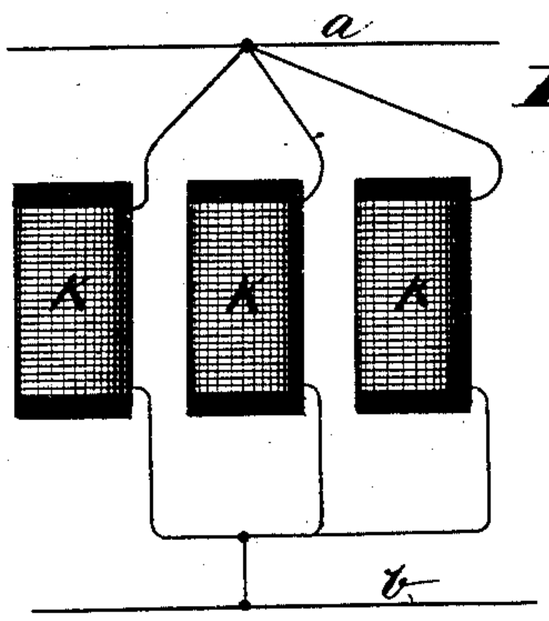


Fig. 6.

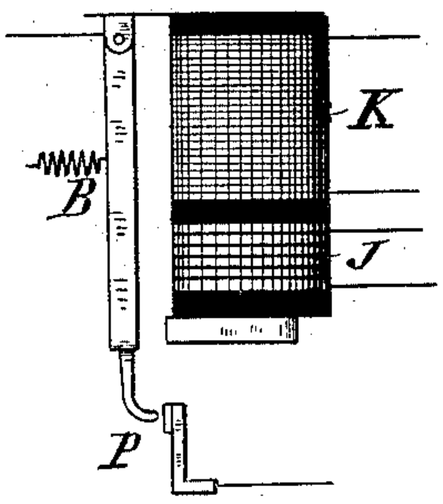
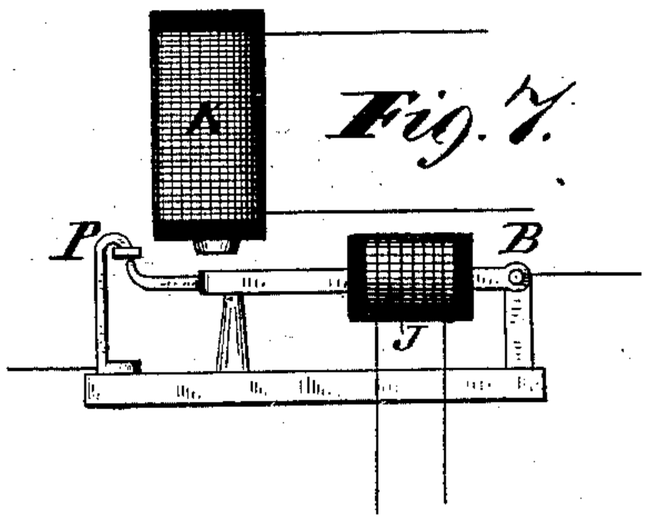


Fig. 7.



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(No Model.) 2 Sheets—Sheet 2.

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DISTRIBUTING APPLIANCE FOR ELECTRIC LIGHTING SYSTEMS.

No. 354,233. Patented Dec. 14, 1886.

Fig. 3.

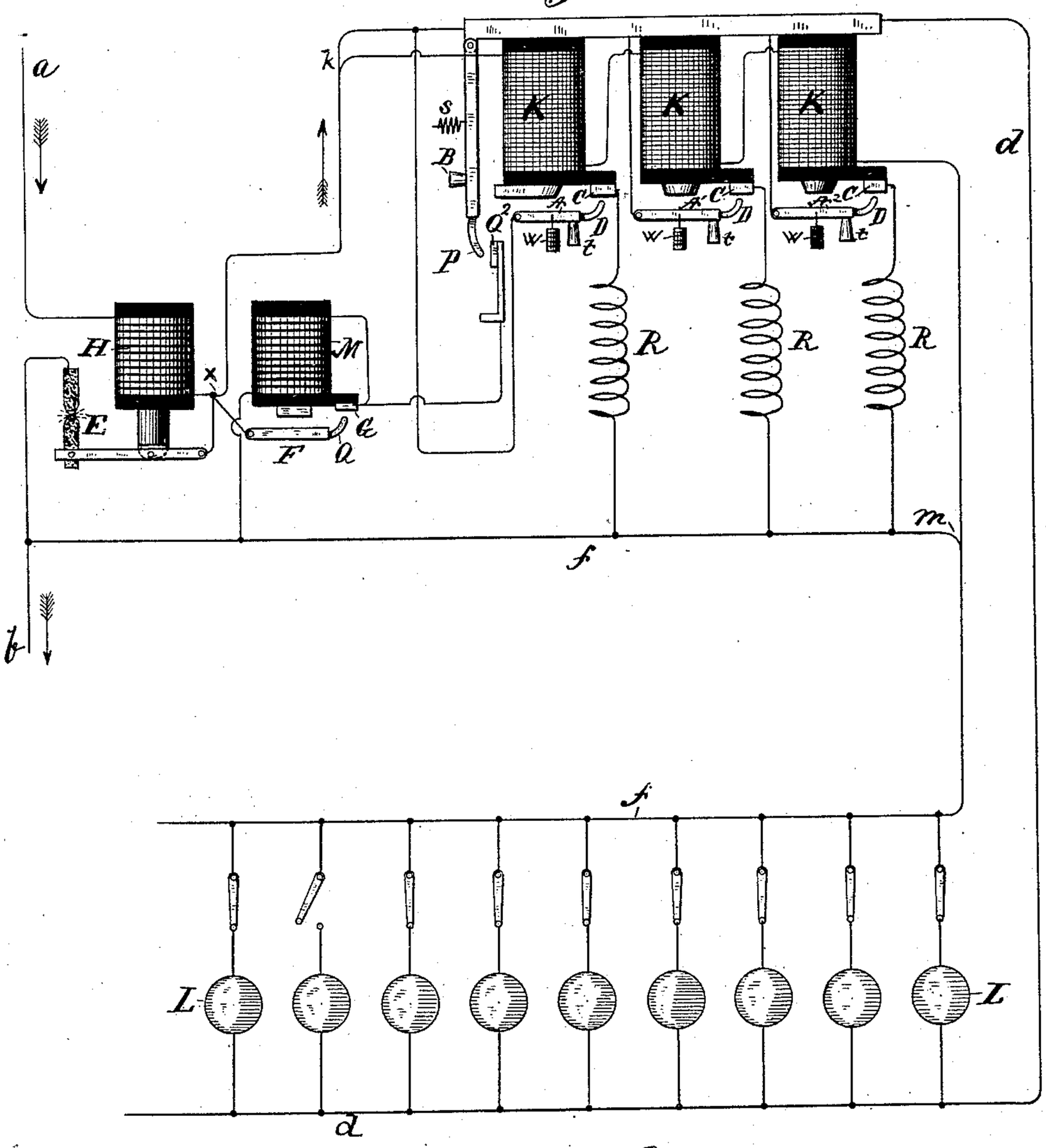
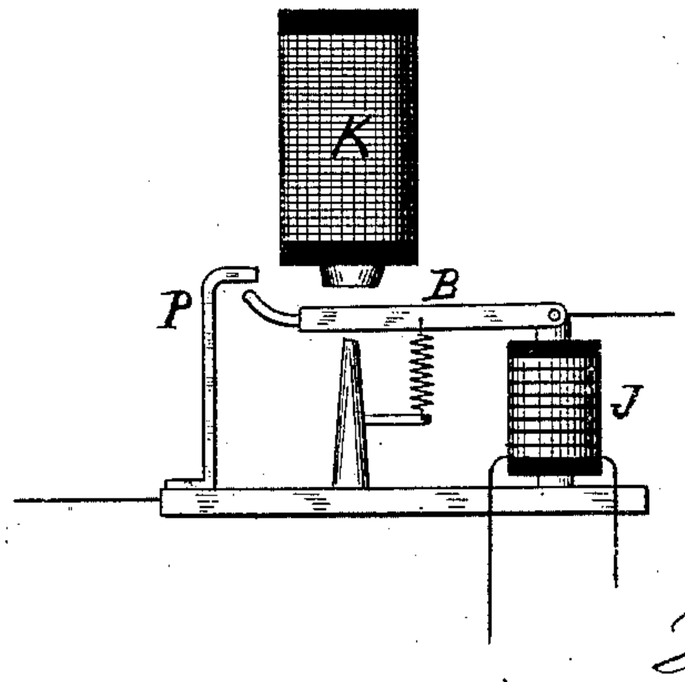


Fig. 8.



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UNITED STATES PATENT OFFICE.

E. WILBUR RICE, JR., OF LYNN, MASSACHUSETTS.

DISTRIBUTING APPLIANCE FOR ELECTRIC-LIGHTING SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 354,233, dated December 14, 1886.

Application filed February 1, 1886. Serial No. 190,498. (No model.)

To all whom it may concern:

Be it known that I, EDWIN WILBUR RICE, Jr., a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Automatic Distributing Appliance for Electric Lighting Systems, of which the following is a specification.

My invention relates to those systems of electric distribution in which the electric lamps or other translating devices are supplied with current in multiple arc from their feeding-conductors, and its object is to furnish a means whereby the electric potential between the two feeding-conductors may be kept uniform despite any changes in the number of multiple-arc branches through which circuit may be established, to avoid danger to the lamps or other translating devices from abnormal differences of potential due either to the removal of a large number of the electric lamps or other translating devices from circuit, and to also provide a means whereby a group of electric lamps or other appliances arranged in multiple arc upon a main line passing through a number of such groups, or through other devices arranged in series with the groups, may be protected from injury by abnormal current flow on the main line.

My invention is intended more especially for application to those systems of distribution in which a line carrying a current of high potential is divided into branches at one or more points, in which branches are placed incandescent electric lamps or smaller arc lamps than are employed on other portions of the system.

The invention is adapted to be employed in what is known as a "combined arc and incandescent system," in which, as is well understood, the usual arc-light conductor containing arc lights in series with one another is split at one or more points into smaller branches containing incandescent lamps.

The invention comprises novel arrangements of switching magnets and branches or sub-circuits containing artificial resistances that are to be automatically substituted for branches containing incandescent lamps when said lamps are extinguished, or a branch containing a lamp is in any other way ruptured.

The combinations of apparatus constituting the invention will be first described in connection with the accompanying drawings and then more specifically designated in the claims.

Referring to the drawings, Figure 1 is a side elevation of a switch appliance that may be used in carrying out my invention. Fig. 2 is a front view of the same. Fig. 3 illustrates diagrammatically the connections of the apparatus when it is applied to a group of incandescent lamps or other translating devices placed at any given point on an electric circuit. Fig. 4 is a longitudinal section of a preferred form of switching-magnet. Fig. 5 illustrates a modified way of connecting the switch-magnets to the circuit. Figs. 6, 7, and 8 show in side elevation switching-magnets having a compensating coil applied or combined therewith after a manner to be hereinafter described.

R R R indicate a set of artificial resistances, which may be either rods or blocks of poor conducting material, or may be formed of coils of fine wire wound upon non-conducting spools or holders, as shown. These resistances are each constructed or adjusted to oppose an electrical resistance the equivalent of the resistance of one of the incandescent lamps or other translating devices L, arranged in multiple arc, as shown in Fig. 3. They are automatically introduced into multiple-arc connections, as will be more fully hereinafter set forth, by the agency of electro-magnets K K K, on the extinguishment of lamps or the breakage of the multiple-arc connections containing said lamps.

The switching is effected by means of the armatures A A′ A^2 for the electro-magnets, which armatures are suitably pivoted, as indicated, in the frame or support for the parts, and are loaded or otherwise restrained by suitable retractors, consisting of springs or weights W, weights being preferred, inasmuch as they will oppose substantially the same retracting influence in all positions of the armature, whether the same be fully retracted or be drawn up in proximity to the pole of the magnet. The armatures have, as usual, a range of movement between a back stop, *t*, and a front stop, C, which latter forms, in conjunction

with a contact-point, D, upon the armature-lever, one of the electrodes of the switch, so that when the armature is drawn up circuit is closed between the points D C.

The electro-magnets K K are placed in a multiple-arc branch or derived circuit around the group of resistances R R.

In addition to the switches described, there is a switch-lever, B, acted upon by one of said magnets K, or by an auxiliary magnet placed in a derived circuit, so as to be affected by an increase in the difference of potential between the sets of supply-conductors furnishing the current to the group of lamps.

The switch-lever B controls the action of an electro-magnet, M, preferably of low resistance, which latter in turn works a lever that closes a low-resistance branch around the group of lamps, and in so doing includes its own coils, or a portion of them, in said low-resistance branch.

A third switch is operated by an electro-magnet, H, whose coils are in the main-line circuit, by which current is furnished to the supply-conductors for the group of lamps, magnets, and resistances. The switch for said latter electro-magnet is composed, as indicated more clearly in Fig. 3, of a lever to which the core of the magnet is connected, and which lever, when the core is drawn within the coils by excess of current, brings into contact with one another the two carbon points E, which are connected so as to complete a low-resistance branch around the group of lamps or other translating devices.

The forms of all the magnets described may be varied, as desired, and the number of magnets K used may be increased or diminished at pleasure, as will be understood from the subjoined description of the invention, their object being simply to substitute artificial resistances R for lamps or other translating devices L L, that may be switched off the circuit, or may be damaged by breaking of the filaments or other connections.

The connections and operations of the apparatus will be readily understood from a description of Fig. 3, where the main line is indicated by the letters *a b*, at some point in which the coils of the electro-magnet H are included, as shown. After passing the coils of magnet H, the circuit is carried to the frame of the magnets K, for the purpose of forming an electrical connection with the armatures A for said magnets, and with the switch-armature B and the contact carried thereby. The circuit is continued to the group of incandescent lamps L L by the wire *d*, forming a feeding-conductor for the group, and the wire (indicated by *f*) conveys the current, after it has passed through the group of lamps, to the main-line conductor *b*.

The connection *d* might be made at any point after the current passes the magnet H. As indicated, the lamps L L form a group arranged in multiple arc between the two supply-conductors *d f*, and may be placed at any convenient distance from the rest of the apparatus, which latter may be suitably inclosed in a protecting-box.

The resistances R R R are placed in normally-open branches, as indicated, by connecting one terminal of each to the conductor *f* in any desired way, and the other terminal to a contact-stop, C, so that, as will be obvious, the closure of contact at D C will introduce an artificial resistance R into a branch which, electrically considered with relation to the supplying-conductors, is the same as a branch containing an incandescent lamp L, or other translating device.

The coils of the electro-magnet M, which are preferably of low resistance, are in a circuit from switch-lever B through circuits P Q^2 to the return wire or conductor *f* or *b*, so that on closure of contact by the operation of lever B the electro-magnet M will be energized, and will thereby draw up its armature F, thus forming connection at contact-stops Q G, the latter of which is connected through the coils of magnet M with the return-conductor *f* or *b*, while the former, Q, is connected through lever F with the leading or supply wire *d* or *a* at a point, *x*, so that on establishment of connection at Q G a branch is formed that is a derived circuit to the group of lamps L through the electro-magnet M. It will be apparent, therefore, that the current in the branch thus established serves to hold the armature F up and preserve the branch circuit at contact Q G.

The electro-magnets K K K are connected in series with one another from a point, such as *k*, on one supply conductor or circuit to a point, such as *m*, of the return-conductor, so that they are practically in a derived circuit around the group of lamps L L and the artificial resistances R R R, or such of them as may be in circuit. The magnets K K K, as thus connected, are made to have a combined resistance that is quite high compared with that of any lamp L, and being thus connected will respond in magnetic strength to any change of electro-motive force or difference of potential between the circuits or conductors connected to opposite sides of the group of lamps.

The magnets might be connected, as in Fig. 5, in multiple arc with one another between the positive and the negative supply conductors or mains; but the arrangement shown in Fig. 3 is preferable, inasmuch as there is less waste of current, unless the wire used is very fine.

The construction of magnet which I prefer to employ, but which I do not claim in itself, is shown in Fig. 4. The magnet is wound with a wire of size and length depending on the current and electro-motive force required to operate it. It is also provided with a copper shell or completely inclosed by a band or circuit of any good conducting material located between, over, or beneath the coils, though the best position is directly surrounding the core of the magnet, as indicated in the figure.

The object of this covering or conducting band is to check the action of the magnets upon their armatures, or to make them sluggish in operation, so that they will only respond to changes of condition of fair duration in drawing up their armatures.

As before stated, the armature or switch B, when the same is employed, may have a separate magnet K instead of being arranged so as to be attracted by one of the poles of the magnet K in the manner shown. If a separate magnet be used, it should have its coils placed like those of the magnets K K K in a separate derived circuit around the lamps, or in the same circuit with said magnets.

The armatures D D are loaded with weights of sufficient amount to cause them to remain against their lower stops and unattracted by the magnets K K K so long as the full number of lights L L or other translating devices are connected in multiple arc with one another, or so long as there are established the normal number of multiple arc connections between the feeding conductors or poles of the main line, either through lamps or through artificial resistances substituted for lamps. The armatures are so adjusted, however, that when drawn up into closer proximity with the pole of the magnet they will retain such attracted position with a normal strength of current in a magnet-coil, K K K—that is to say, with the strength of current that exists when there are the normal number of branch circuits established, and therefore a normal difference of potential between the positive and negative supply-conductors.

The operation is a follows: The current entering at the point *a* passes through the coils of magnet H, and from thence through the conductor *d* to the lamps L L, wire *f*, and out by conductor *b* when all the lights are in use. A very small portion, however, passes through the derived circuit or branch of high resistance established through the coils of magnets K. If, now, a light L be extinguished by the operation of a switch of any desired kind, or if its filament be broken, or if the branch containing said light or other translating device be severed in any way so as to take away the path for the current through such branch there will result an increase in the difference of potential between the supply-conductors *d* and *f*, and the magnets K K K will be energized more strongly, owing to the increased flow of current through their coils. Their armatures will thereby be subjected to stronger attraction, and one or more of them will be drawn up. If more than one be drawn up, the armature of only one will remain attracted, provided the range of motion of the armature is made so small as not to give a great increase of attractive force by the approach of the armatures to the pole of the magnet. In general, a motion that will give a slight but sufficient increase of attractive influence is desirable. The attraction of the armatures as described results in the closing of the path for the current through one of the resistances R, whichever it may be, and restores (since the resistance R equals that of the lamp) the conditions of electro-motive force to what it was before the action just described took place; but the attracted armature D does not fall away, although the magnet K has resumed its normal force, because said armature is nearer to the magnet in its attracted position. If, now, another lamp be turned out, another armature D is in like manner attracted, and compensates for the extinguishment, and the extinguishment of the third lamp is likewise compensated for by the third armature D putting in a resistance corresponding to it. The parts might be further multiplied to compensate for all the lights in the group; but in practice where it is desired to guard against possible breakage of filaments the number shown will be ample.

The fact that but one armature will remain up, though several be drawn up by the extinguishment of a single lamp, is due to the circumstance that by the closure of circuit through, say, two artificial resistances R, when but one branch containing a lamp L is broken, there will result an increase in the total number of branches and a lowering of the difference of potential between the supply-conductors below normal, so that the magnetic power of the magnets K K K will not be maintained. On one of the armatures, however, falling away so as to cut out or break the circuit of its resistance, a restoration of power to normal will take place and the more slowly acting of the two armatures will remain attracted.

During the operation just described the brilliancy of the lights will be little, if any, changed. As will be obvious, the introduction of the lamps L or the closing of multiple-arc branches containing them or including other translating devices, instead of the opening of such branches, will cause the armatures to drop away successively from the magnets, thus successively opening the multiple-arc branches containing resistances, this action being in virtue of the fact that the normal difference of potential between the supply-conductors only exists when there are the proper number of branches containing translating devices or resistances the equivalent of the same to divide the current into fractions for which the apparatus has been designed.

Too many derivations or branches lower the difference of potential between the conductors, and too few raise it. When it is raised, one or more armatures are attracted, and when it is lowered one or more are released.

The switch devices, consisting of the armature-lever B and the parts combined and controlled by the same, are designed to come into operation on the establishment of a difference of potential greater than that for which the switch-magnets K K K and the resistances R R, &c., can compensate.

The switch devices, consisting of the lever B

and parts controlled by the same, are not absolutely necessary to the action of the apparatus in the manner before described, but they are nevertheless very desirable adjuncts in cases where any sudden and large increase of difference of potential between the supply-conductors *d* and *f* may come into existence—as, for instance, in the case of a sudden rupture of the conductor *d* or *f* at any point near the lights or other translating devices, or between said devices and their resistances R R R. In this case the magnets K K K will not only attract the armatures D D D and introduce the resistances R R R, but will also become energetic enough to attract the armature B, which has its retractor S adjusted to require for operation a considerably greater energy of the derived circuit-magnets K K K than is required for operating the armatures D D D. The armature B, so attracted, closes the contact at P, allowing the current to flow from *a* to *b* through the low-resistance magnet M, since the armature B is in connection with the wire *a d* through the supporting-frame. The current so passing at once magnetizes M, which attracts its armature F and closes the contacts G Q, thus effecting an action which keeps shunted the coils of the resistances R R R and the lights L L, and prevents any possible damage to either device.

It is desirable that the action of the armature B in closing its contact and bringing into action the magnet M should be itself independent of any changes in the strength of the line-current and solely dependent on a power of the derived-circuit magnet, indicating only a difference of potential not due to excessive current on the line. To give the said magnet a compensated power for the purpose, I find it desirable to wind the magnet K, which operates to attact the armature B, with a second winding of coarse wire, (indicated in Fig. 6 at J,) which coil is traversed by the main current, being inserted at any point in the line supplying the lamps. The direction of flow of current through this coil is in opposition to the flow of current in the derived-circuit coil K. Any increase in the power of K, therefore, due to excessive current establishing an increased difference of potential between the lamp-terminals, will be compensated by a flow of current in the magnet-coil J, similarly increased, it being on the main line. The amount of winding on J is small, because the effect of the derived-circuit coil is small.

In Fig. 7 the coil J in the direct circuit is wound upon the armature B itself, and a separate magnet K in derived circuit to the lamp-terminals is provided for actuating such armature. In this case the winding of J is such as to produce a pole at the end of B (attracted by the magnet K) opposite in character to that produced by K inductively. Here, again, any increase in the power of K due to increased current on the line producing excess of difference of potential at the lamp-terminals, will be compensated by a similar increase of current in the coil.

In Fig. 8 the coil J is stationary and the armature B is mounted on a polar extension from its core. The effects are similar to those already described.

It will be observed that in my present invention the switch-controlling devices are arranged to be responsive, to increase in the difference of potential between the two supply-conductors feeding the group of incandescent lamps. In this respect the invention is quite different from any arrangement in which the magnets controlling the switches or completing branches around the lamp are placed individually in the lamp branches, and are arranged so that the rupture of a branch is required before the resistance branch can be completed.

What I claim as my invention is—

1. The combination, with incandescent lamps or other translating devices in multiple arc, of switching devices responsive to differences of potential between the supply-conductors, resistances the equivalent of the translating devices controlled and thrown into multiple-arc connections by said switching devices on a difference of potential produced by the throwing out of a translating device, and a switching mechanism for establishing a multiple-arc connection of comparatively low resistance, said mechanism being adjusted to respond only to a difference of potential above that required for operating the first-named switching devices.

2. The combination, with incandescent lamps or other translating devices supplied in multiple arc, of governing devices responsive to differences of potential between the supply-conductors consequent upon the throwing out of a translating device, means controlled by said mechanism for restoring the difference of potential to normal, and switch devices, and a branch of comparatively low resistance controlled thereby, said switch being also responsive to differences of potential between the supply-conductors, but adjusted to respond only to a difference of potential greater than that required to operate the aforesaid governing devices.

3. The combination, with the artificial resistances and switching devices responsive to differences of potential produced by the throwing out of a translating device, of a supplemental switching device adjusted to respond only to a difference of potential greater than that required for operating the first-named switching devices, and a compensating main circuit-coil, J, as and for the purpose described.

4. The combination, with a number of translating devices in multiple arc, of two or more magnets in the same derived circuit or multiple-arc branch, a switch for each magnet, and an artificial resistance controlled by each switch and approximately equal to the resistance of a multiple-arc branch containing a

translating device when the said branch is closed and the translating device in it is in action.

5. The combination, with incandescent lamps or other translating devices in multiple arc, of two or more artificial resistances in separate normally-open branches, and two or more switches individually controlling said resistances and responsive to increased current in a multiple branch of high resistance common to said switches.

6. In a system of electric distribution, the combination, with two or more translating devices in multiple arc, of one or more magnets whose coils are in a derived circuit around the translating devices and whose armature or armatures remain immovable in either attracted or unattracted position during the continuance of a normal difference of potential at the terminals of the group of translating devices, artificial resistances uniform individually with the resistances of the individual branches containing the translating devices, and an electric switch or switches operated by said armature or armatures for introducing said resistances into multiple arc branches on an increase of difference of potential due to rupture of circuit through the branch or branches.

7. The combination, with incandescent lamps or other translating devices arranged in multiple arc, of devices responsive to a difference of potential between the supply-conductors consequent on the throwing out of a translating device for restoring the difference of potential to normal, a switch responsive only to a further increase in the difference of potential, and an electro-magnet controlled thereby for operating a switch that serves to close a multiple-arc branch of comparatively low resistance, said electro-magnet having coils included in the low-resistance branch.

8. In combination with a system of electric distribution, as described, a switching-magnet, H, in the main circuit at all times, and the carbon contacts E, closed upon occurrence of an abnormal current, and controlling a low-resistance branch.

9. The combination, with the translating devices, of two or more electric switches controlled by current in a derived circuit around the translating devices, said switches being provided with retracting-weights, as described, and adjusted to retain either an attracted or unattracted position with a normal strength of current in a derived circuit, and branch circuits around the several translating devices, controlled, respectively, by said switches, as and for the purpose described.

10. In a system of distribution for electric currents, the combination of an incandescent lamp or lamps, a magnet in derived circuit thereto, an armature for said magnet adjusted to remain in either an attracted or unattracted position when said magnet is normally energized, an artificial resistance, R, the equivalent of the lamp, and a contact controlled by the armature for putting said resistance in derived circuit to the branch containing the lamp upon the rupture of said branch.

11. The combination, with the switch-magnets in the derived circuit, of armatures D, provided with retracting-weights, and adjusted, as described, to retain either an attracted or unattracted position with a normal strength of the magnet.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 28th day of January, A. D. 1886.

E. WILBUR RICE, JR.

Witnesses:
ELIHU THOMSON,
J. W. GIBBONEY.