(No Model.)

2 Sheets—Sheet 1.

R. H. MATHER.

MULTIPLEX ELECTRIC ARC LAMP.

No. 306,764. Patented Oct. 21, 1884.

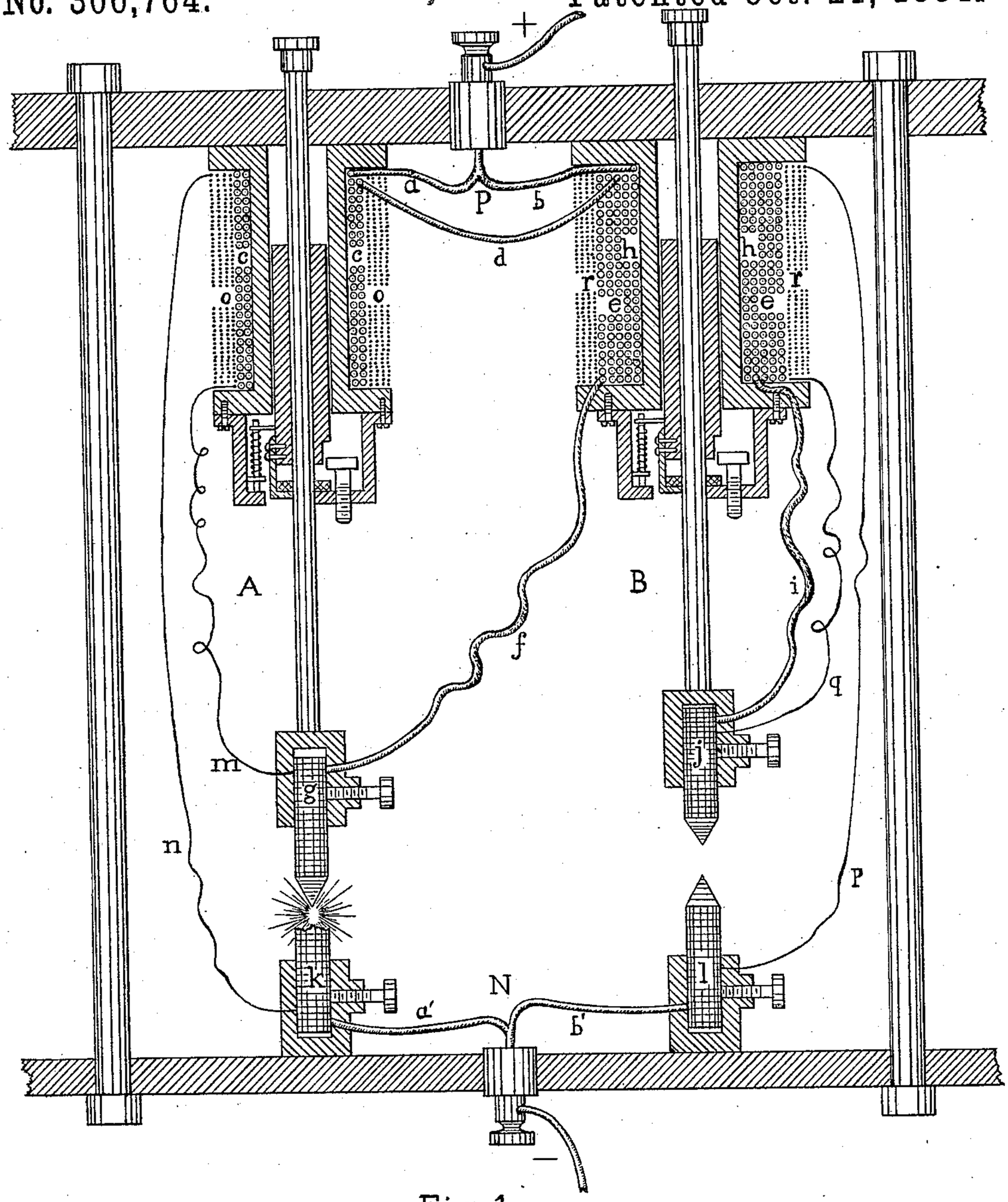

Fig. 1.

Witnesses:

George C. McKee,
Charles W. Manwaring.

Inventor,

Richard H. Mather,
By his Attorney,
Willard Eddy.

(No Model.) 2 Sheets—Sheet 2.

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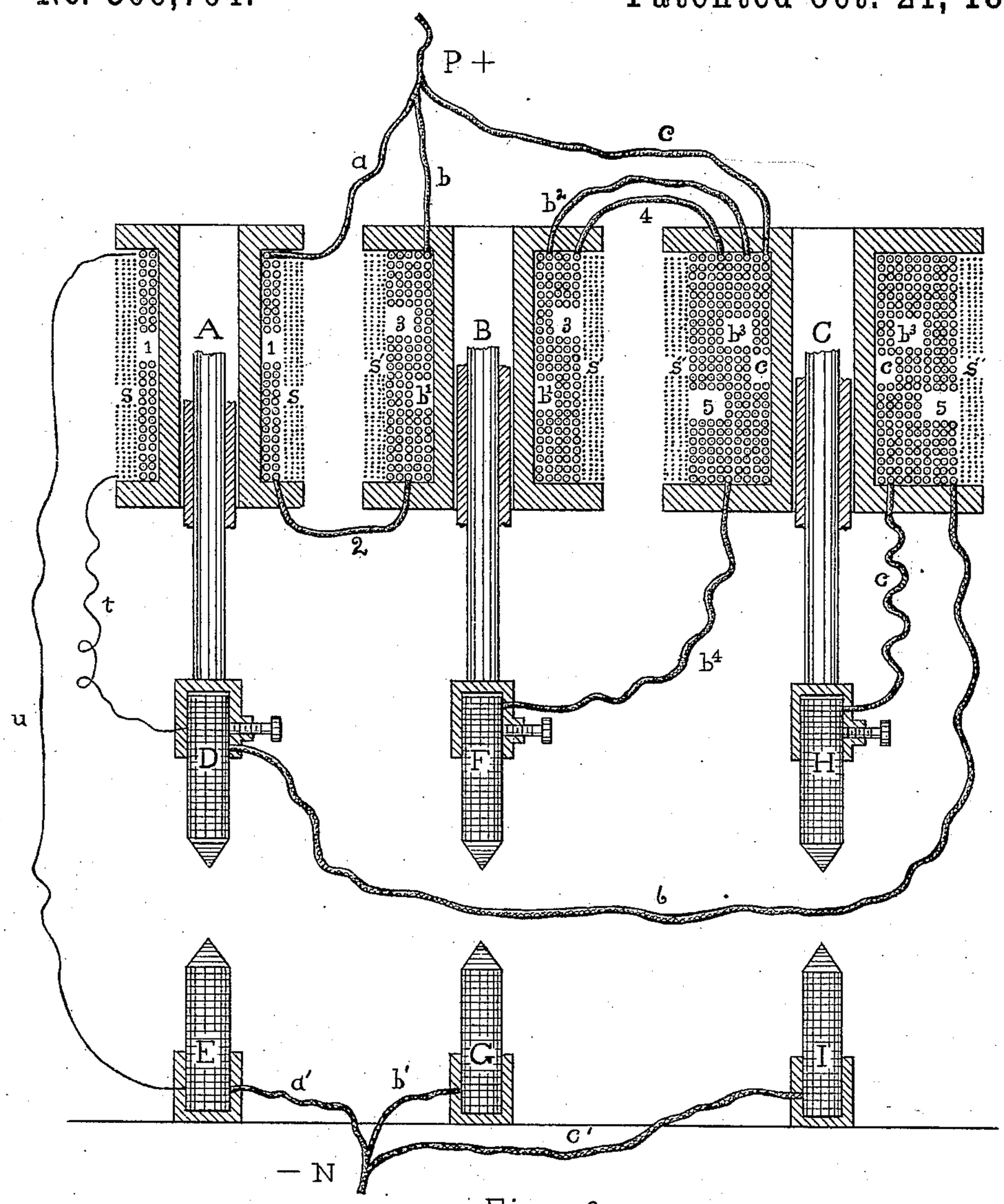

Fig. 2.

Witnesses:
George C. McKee,
Charles W. Kennaring

Inventor,
Richard H. Mather,
By his Attorney,
Willard Eddy.

UNITED STATES PATENT OFFICE.

RICHARD H. MATHER, OF WINDSOR, CONNECTICUT.

MULTIPLEX ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 306,764, dated October 21, 1884.

Application filed August 30, 1883. (No model.)

To all whom it may concern:

Be it known that I, RICHARD H. MATHER, a citizen of the United States, residing in the town of Windsor, county of Hartford, and State of Connecticut, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a full, clear, and exact description, whereby a person skilled in the art to which it appertains can make and use the same, reference being had to the accompanying drawings.

My invention relates to that class of electric-arc lamps in which two or more sets of carbons are combined to operate successively and afford a continuous light, regardless of the consumption of the carbons and without any manual interference.

The object of my invention is to so construct, arrange, and connect a series of single lamps as to make a duplex or multiplex lamp, which will burn until the several sets of carbons are successively consumed, and in particular to accomplish this object by means of a compound automatic switch, whose contact-points are the carbons of the lamp.

It is proper to observe that my invention is not limited in its application to any specific form of lamp. I shall describe it, however, in the form shown in the drawings, as applied to an electric lamp and regulator thereof having a carbon-holder with a rod or tube which slides through a friction-clutch, such clutch being operated by a differential magnet or its equivalent, to move such carbon rod or holder, and thus to separate the carbons and produce the voltaic-arc light.

The distinctive principle of my invention is conceived to lie in the construction and use of one or more supplementary coils of insulated conducting-wire, adapted to re-enforce the action of the primary coil of the feed-magnet, together with appropriate connections so arranged that the electric current shall automatically control and operate in succession the several members of an electric-arc lamp consisting of several members.

So far as concerns this case, I disclaim all things which are claimed in my application No. 113,578, for a patent for improvement in electric-arc lamps, filed December 5, 1883.

I proceed to point out the best mode in which I have contemplated applying the principle.

In the accompanying drawings, Figure 1 is a vertical section of a duplex lamp embodying my invention as applied to an electric lamp of two members, and Fig. 2 is an isometrical view of a triplex lamp embodying my invention.

In Fig. 1, A and B are two single electric-arc lamps supported in a suitable frame. These lamps are of any ordinary construction, are provided each with an automatic feeding mechanism of the kind above mentioned, and indicated in the drawings, and are peculiar in their construction only as hereinafter mentioned. A large wire, P, connected with either pole of the generator separates at any convenient point into two branches, *a* and *b*. The branch *a* proceeds to the magnet in lamp A, is wound about the core thereof, and constitutes the large wire coil or main helix *c*. After being so wound about said core in the usual manner, the branch wire *a*, on leaving said magnet, passes, as shown at *d*, to lamp B, and there is wound about the core of the electro-magnet of lamp B, as a supplementary coil *e*, adapted to re-enforce the electro magnetic action of the primary coil *h*, hereinafter mentioned. The supplementary coil *e* should be wound to a slightly greater efficiency—say ten per cent. greater—than is the said primary coil *h*. After passing a suitable number of times about the core of the magnet in lamp B, where it constitutes the helix *e*, as described, the said branch wire *a* leaves the magnet of lamp B and passes by the line and wire *f* to upper carbon *g* in lamp A, and is electrically connected therewith. The branch wire *b* proceeds from P to the magnet of lamp B, is wound about the core thereof, and constitutes the said primary coil or main helix *h* in lamp B. After so passing a suitable number of times about the core of the magnet in the lamp B, where it constitutes the helix *h*, before mentioned, the branch wire *b*, on leaving the magnet last mentioned, passes by the line and wire *i* to upper carbon *j* in lamp B, and forms an electrical connection therewith. It is to be understood that the supplementary helix *e* is deeper and more powerful than either of the coils *h* or *c*, and that *h* and *c* are practically equal to each other. A

large wire from the other pole of the generator separates at any convenient point N into two branches, a' and b', which are respectively connected with the remaining carbons k and l.

Over the coil e in lamp A is wound a fine wire, m o n, forming the fine-wire coil o. One end of this wire is connected with the carbon g, and the other end of the same is connected with carbon k, whereby a simple differential magnet is formed in the lamp A. In like manner a fine wire wound over the coils h and e, and connected by the wires p and q with the carbons j and l, constitutes the shunt-coil r, and creates a differential magnet in lamp B.

It is to be understood that the coil e is wound to a greater strength and efficiency than the coil r.

In that class of lamps which, instead of a differential magnet, contains a fine-wire magnet and a coarse-wire magnet pulling in opposite directions the supplementary coil is to be wound on the same core with the main coil.

The coils h, e, and r may be arranged in any order; but I prefer to arrange them in the order named, beginning at the core. The same is true concerning the coils c and o.

Such being the construction of my duplex lamp, the mode of its operation is as follows: The connections being made as above described, and the carbons of each set separately being in contact, and the generator being active, the electric current from P follows the branch wires a and b through both lamps as follows, viz: That portion of the current which follows the branch a passes through the helix c, the connecting-wire d, the supplementary helix e, the connecting-wire f, the carbons g and k, and the branch a' to N and the generator. That portion of the current which follows the branch b passes through the main helix h, the connecting-wire i, the carbons j and l, and the branch b' to N and the generator. A small fractional part, however, of the current through P, a, c, d, e, f, g, k, a', and N as it passes from g to k is diverted through the helix o and the fine wire m and n, and in like manner a small fractional part—for instance, one per cent. of the current through P, b, h, i, j, l, b', and N—as it passes between the carbons j and l is diverted through the fine wire p and q and the helix r. Such is the course pursued by the electric current the instant the above conditions are fulfilled. The effect of the passage of the electric current from P to N in the courses described is first visible in lamp B, where, on account of the fact that the coils h and e together in lamp B are of greater efficiency than is the single helix e in lamp A, the lifter in lamp B moves first and the carbons j and l separate from each other, whereby the current which passed between j and l is diverted and made to pass through lamp A. When the carbons j and l separate, the current through the main coil h is interrupted; but at the same time the whole current is now passing through the main coil e and the supplementary coil e, so that the current which previously was passing through the main coil h now passes through the supplementary coil e, together with the current which was at first passing through the said coil e, so that the effective magnetism of the magnet in lamp B is practically constant, whether the carbons j and l are in contact or not. The reason why the arc is not established at j l when the carbon j is first raised through the efficiency of coils e and h lies in the fact that by the raising of the carbon j the current P b h i j l b' N is short-circuited through P a c d e f g k a' N. The increased effect which is produced in the magnet of lamp A by the separation of the carbons j and l, in the manner described, raises the lifter and rod in lamp A, and separates the carbons g and k, so that the voltaic-arc light then appears in lamp A. This light continues until the feed in lamp A is arrested by means of the stop on the carbon rod in lamp A, and as the carbons in lamp A are gradually consumed while the feed has been arrested, the voltaic arc between g and k lengthens, and an increasing current is passed through the shunt-coils o and r by the way of the fine wires m n and q p. As the current through the shunt-coils increases, the shunt-coil r overcomes and neutralizes the effect of the supplementary coil e, and so allows the lamp B to feed till its carbons j and l meet in electrical connection. The whole current which passed through the carbons g and k at once passes through the lamp B, the light in A goes out, and the increased current through the helix h causes the carbons j and l to separate, so that the voltaic-arc light is produced between them. It is to be understood that the electric current through the shunt-coils is never interrupted in either member of this duplex lamp while the latter is in operation.

In order to apply to a lamp of three members or elements the principles of my invention, which have already been shown in their application to a duplex lamp, it is necessary to increase, modify, arrange, and connect the elements, as shown in the drawings, Fig. 2, and as hereinafter explained.

In Fig. 2, A, B, and C are the magnets which severally operate the feed mechanism of the three members of such lamp, respectively. A, the magnet of the first member in the series, is constructed in the same way as is the magnet above described in the member A of my duplex lamp hereinbefore described. Also, B, the magnet of the second member of my triplex lamp, is constructed in the same way as is the magnet, above described, of the member B of my duplex lamp aforesaid. The magnet C of the third member of my triplex lamp is similar to the magnet B; but, instead of being wound with a primary coil, a supplementary coil, and a shunt-coil merely, C has a primary coil, c, a first supplementary coil, b^3, and a second supplementary coil, 5, besides the fine-wire shunt-coil s''.

The four coils c, b^3, 5, and s'' in magnet C

may be arranged in any order; but I prefer them wound in the order named, beginning at the core. The first supplementary coil b^3 should be of about ten per cent. greater efficiency than the primary coil *c;* and the second supplementary coil, 5, should in like manner be of somewhat greater efficiency than b^3; but all the primary coils 1, b', and *c* should be of equal efficacy. The first supplementary coils, 3 and b^3, should also be equal. All the coils or helices represented in Fig. 2 are of coarse wire, excepting the coils *s*, *s'*, and *s''*, which are of fine wire, and are connected as shunts to their respective carbons in the usual manner of differential magnets.

In my triplex lamp a large wire, P, Fig. 2, connected with one pole of the generator, divides into three branches, *a*, *b*, and *c*, and a corresponding large wire, N, from the other pole of the generator separates into three branches, *a'*, *b'*, and *c'*, which are electrically connected with the three lower carbons of the triplex lamp—one branch with each carbon. The remaining connections in this lamp will be readily understood from the operation of this lamp, as hereinafter explained, from the drawings, Fig. 2, and from the foregoing description of like connections in my duplex lamp.

Such being the construction of my triplex lamp, the mode of its operation is as follows: When the current is not passing through the lamp, the positive and negative carbons of each set or member are in actual contact, but when a current is passed through the lamp, the connections having been made as indicated, the electric current from P, Fig. 2, follows the branch wires *a*, *b*, and *c* through the three members of the lamp, as follows, viz: That portion of the current which follows the branch *a* passes through the helix 1 in magnet A, and thence follows the connecting-wire 2 to magnet B, where it passes through the supplementary helix 3; then it follows the connecting-wire 4 to magnet C, where it passes through the second supplementary helix, 5; thence it follows the connecting-wire 6 to the upper carbon D; thence through the lower carbon E, and thence by the branch wire *a'* to the large wire N and the generator. In like manner that portion of the current which follows the branch *b* passes through the helix *b'* in magnet B, thence follows the connecting-wire b^2 to magnet C, where it passes through the helix b^3, whence it follows the connecting-wire b^4 to the upper carbon F, and thence goes by the way of the lower carbon G and the branch wire *b'* to the main wire N and the generator. In like manner that portion of the current which follows the branch *c* passes through the helix *c* in magnet C, thence follows the connecting-wire *c* from magnet C to the upper carbon H, and thence passes by the way of the carbons H and I and the branch wire *c'* and the wire N to the generator. A small fractional part, however, of the current through P *a* 1 2 3 4 5 6 D E *a'* N—say one per cent. of that current—in passing from D to E is diverted through the shunt-coil *s* and the fine wire *t* and *u*. In like manner a small percentage of the current through P *b* *b'* b^2 b^3 b^4 F G *b'* N in passing from F to G is diverted through the shunt-coil *s'* by the way of fine wires, (not shown in the drawings,) and in a similar manner a small percentage of the current from H to I is diverted through the shunt-coil *s''*. Such is the course pursued by the electric current when the latter is passed through my triplex lamp. The effect of the passage of such current from P to N in the courses described is first visible in connection with magnet C. Since the magnetism produced in C by means of the helices 5, b^3, and *c* is greater than that produced in A or B by means of the coarse-wire coils in those magnets, respectively, the lifter which is actuated by magnet C moves first, and the carbons H and I are separated from each other, whereby the current which at first passed from H to I is now diverted and made to pass through the magnets A and B. When the carbons H and I separate, the current through the main coil *c* is interrupted, but at the same time the whole current is now passing through the main coils 1 and *b'* and the supplementary coils 3, b^3, and 5, so that the current which was before passing through the main coil *c* now passes through the supplementary coils b^3 and 5, together with the current which was at first passing through the coils b^3 and 5; hence the effective magnetism in C is practically constant, whether the carbons H and I are in contact or not. Upon the interruption of the current between H and I in the manner stated the remaining magnets A and B are in practically the same predicament, are connected in the same way, and being, as above stated, constructed in the same way, are caused to operate in the same way, upon the same principles, and subject to the same explanation, and are productive of the same effects in this my triplex lamp as are the corresponding magnets of the members A and B in my duplex lamp, hereinbefore described. In short, the magnets A and B then become the magnets of a duplex lamp of the type hereinbefore described; and when, in the operation of such duplex lamp containing the magnets A and B, the carbons D and E are consumed and separated then the magnets B and C become in turn the magnets of a duplex lamp of the same type and operate in the same way to produce the electric light first between F and G and then between H and I.

From the foregoing it is obvious that in my improved lamp the carbons constitute the contact-points in a compound automatic switch, governing and co-ordinating the action of the several members of the lamp in the manner described.

The principles of my invention, which have now been shown in their application to a duplex and to a triplex lamp, may be applied to

a multiplex lamp of any desired number of members more than three by simple extension and addition without the introduction of any new principle. If all the fine wires and shunt-coils be omitted from any lamps which are in other respects constructed as above specified, such lamps, if not connected in a series, still operate satisfactorily, and may be made so to operate even in a series.

I claim the following as my invention:

1. In an electric-arc lamp containing two or more members or sets of carbons, a differential magnet wound in the ordinary manner, in combination with a differential magnet wound with a primary coil, a shunt-coil, and a supplementary coil, each of said magnets having a variable magnetic efficiency dependent upon the number and electro-magnetic energy of such of the said coils as are brought into operation for the time being, substantially as described, and operating as set forth, for the purpose specified.

2. In an electric-arc lamp, two or more pairs or sets of carbons and a series consisting of a corresponding number of differential electro-magnets, the first of such magnets being wound with a primary coil and a shunt-coil, and the second of such magnets being wound with a primary coil, a shunt-coil, and a supplementary coil, said magnets being connected with each other, as delineated, and each of said magnets having a variable magnetic effect dependent upon the number and electro-magnetic energy of such of the said coils as are energized for the time being, in combination with an equal number of intermediate feed mechanisms actuated by said magnets.

3. In an electric-arc lamp containing two or more members or sets of carbons, a series consisting of a corresponding number of differential magnets in combination, the first of said magnets being wound with a primary coil and a shunt-coil, the second of said magnets being wound with a primary coil, a shunt-coil, and one supplementary coil, the third of said magnets being wound with a primary coil, a shunt-coil, and two supplementary coils, and so on, as described, all of said magnets being interconnected in the manner shown, and each of said magnets having a variable magnetic effect dependent upon the number and electro-magnetic energy of such of the coils thereof as may be traversed for the time being by the electric current, substantially as and for the purpose specified.

4. In an electric-arc lamp containing two or more members or sets of carbons, a compound differential electro-magnet wound with a primary coil, a differential coil, and one or more independent supplementary coils, said magnet having a variable magnetic effect dependent upon the number and the variable electro-magnetic energy of such of the coils thereof as may, for the time being, be traversed by the electric current operating such lamp, substantially as and for the purpose shown.

5. In an electric-arc lamp containing two or more pairs or sets of carbons, a series consisting of a corresponding number of differential electro-magnets, the first magnet in said series being wound with a primary coil and a shunt-coil, the second magnet in said series being wound with a primary coil, a shunt-coil, and a supplementary coil, and the third magnet in said series being wound with a primary coil, a shunt-coil, and two independent supplementary coils, and so on, as described, said magnets being connected with each other, as shown, and each of said magnets having a variable magnetic effect dependent upon the number and variable electro-magnetic energy of such of the coils thereof as may, for the time being, be traversed by the electric current.

6. In an electric-arc lamp containing two or more pairs or sets of carbons, a carbon rod or holder and an electro-magnet wound differentially with two or more independent coils, in combination with intermediate feed mechanism actuated thereby, whereby said carbons may be made to approach, recede, or stay apart, according to the number and variable electro-magnetic efficiency of such of the said coils as may, for the time being, be traversed by the electric current, substantially as shown, and operating as described, for the purpose specified.

7. In an electric-arc lamp containing two or more pairs or sets of carbons, a series consisting of a corresponding number of differential electro-magnets, the first magnet in said series being wound with a primary coil and a differential or shunt coil, the second magnet in said series being wound with a primary coil, a differential coil, and a supplementary coil, the third magnet in said series being wound with a primary coil, a differential coil, and two supplementary coils, and so on, as described, in combination with an equal number of spring-armatures actuated by said magnets similarly or dissimilarly, according to the course pursued by the electric current in passing through said magnets, substantially as and for the purpose specified.

8. An electric-arc lamp containing two or more pairs or sets of carbons whose feed mechanisms are actuated by a series consisting of a corresponding number of differential electro-magnets, the first magnet in said series being wound with a shunt-coil and a differential coil, and the last magnet in said series being wound with a shunt-coil and two or more differential coils, in which lamp each such set of carbons constitutes a pair of the only contact-points in a compound automatic switch regulating such lamp and co-ordinating the functions thereof.

9. In an electric-arc lamp containing two or more pairs or sets of carbons whose feed mech-

anisms are actuated by a series consisting of a corresponding number of differential electro-magnets, the first magnet in said series being wound with a shunt-coil and one differential coil, and the last magnet in said series being wound with a shunt-coil and with two or more differential coils, a compound automatic switch whose contact-points severally coincide with the points of said carbons.

In testimony whereof I have hereunto set my name in the presence of two subscribing witnesses.

RICHARD H. MATHER.

Witnesses:
RALPH H. PARK,
CHARLES E. HUBBARD.