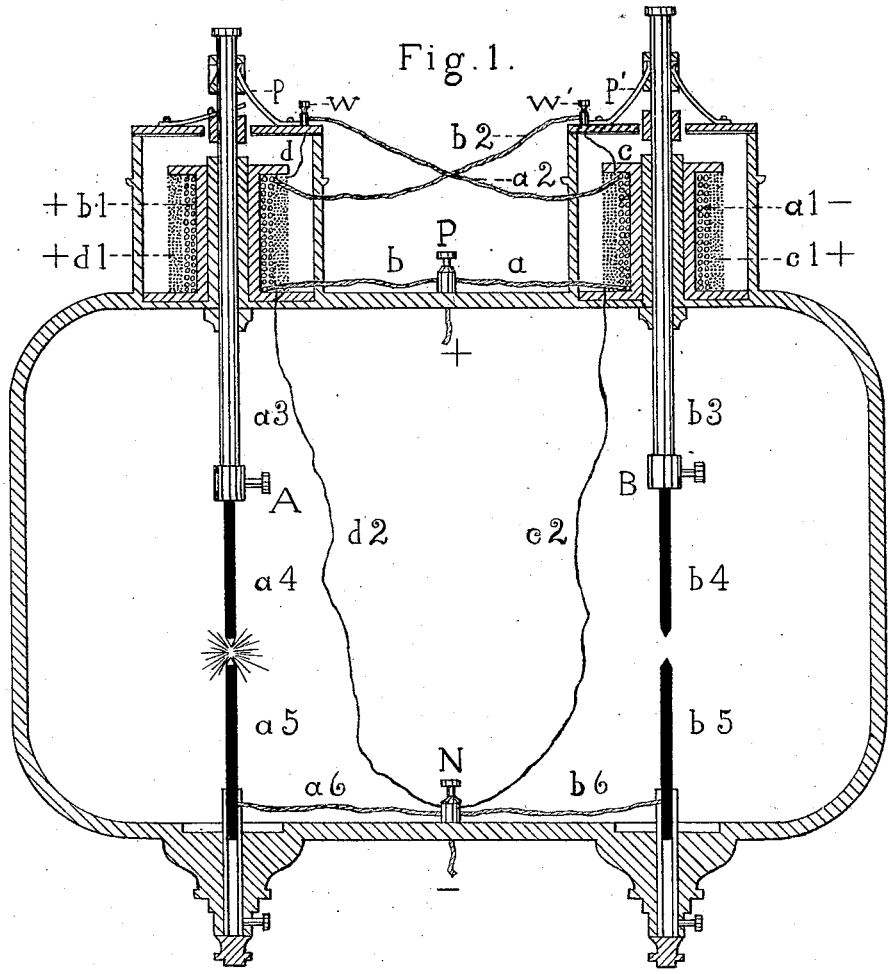
(No Model.) 2 Sheets—Sheet 1.

R. H. MATHER.

MULTIPLEX ELECTRIC ARC LAMP.

No. 306,845. Patented Oct. 21, 1884.

Fig. 1.



Witnesses:

George C. McKee.

Henry E. Platt.

Inventor,

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(No Model.) 2 Sheets—Sheet 2.

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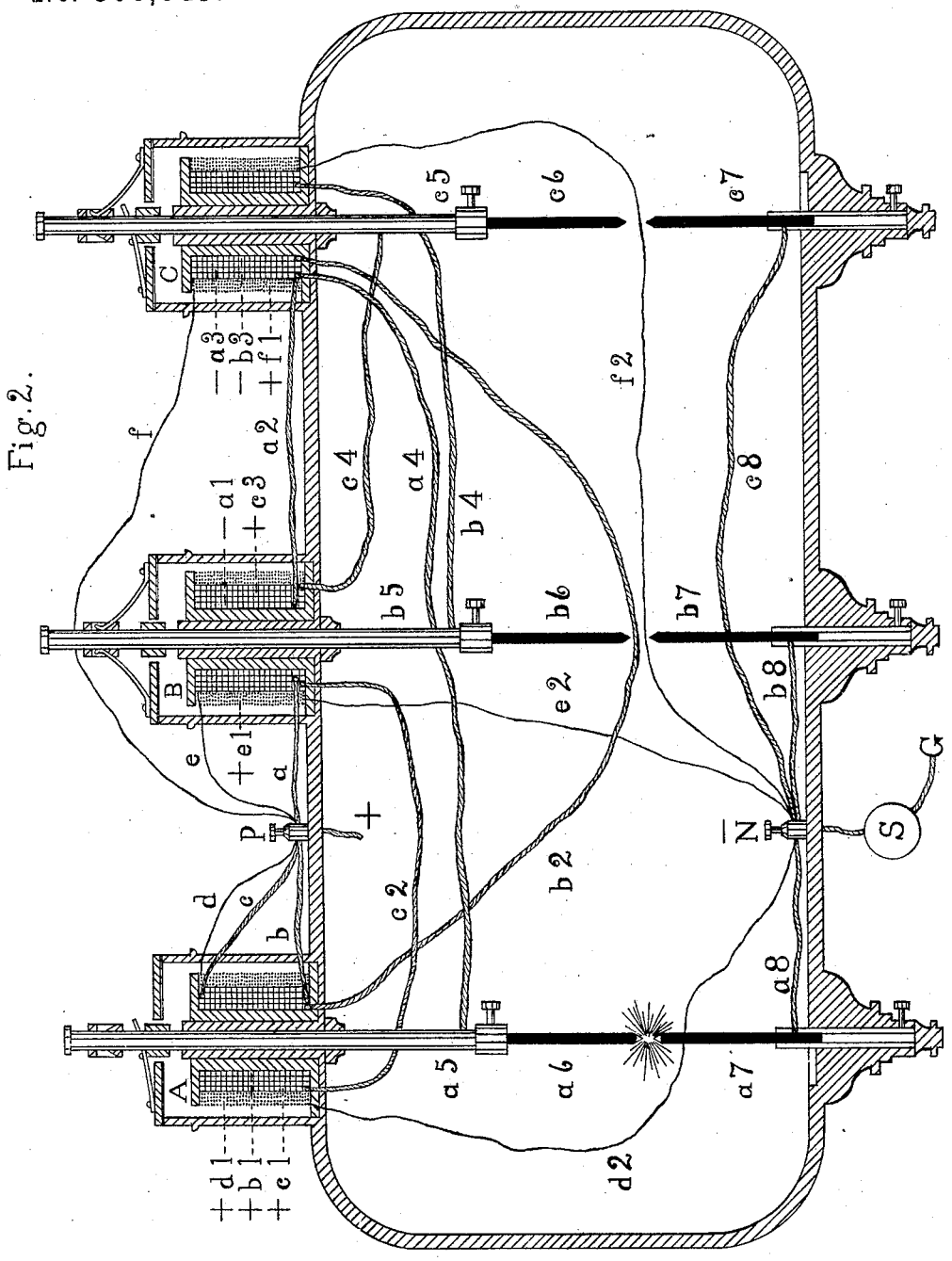
Fig. 2.



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Willard Eddy.

UNITED STATES PATENT OFFICE.

RICHARD H. MATHER, OF WINDSOR, CONNECTICUT.

MULTIPLEX ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 306,845, dated October 21, 1884.

Application filed December 5, 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 lamps in which two or more sets of carbons are combined to operate successively in one lamp, and to 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, combine, and connect the elements of a series of single lamps of the general character described in Letters Patent of the United States No. 268,254, issued to me November 28, 1882, as to make a duplex or multiplex lamp which will burn till 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.

My invention is not limited in its application to any specific form of such single lamp, but is applicable to all electric lamps of the general character of my said electric lamp, patented as aforesaid.

I shall describe my present invention, 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 or spring-clamp, the latter being operated by a magnet in a shunt-circuit to produce feed, and by the recoil of a spring to separate the carbons.

The distinctive principle of my invention is conceived to consist in a peculiar construction and use of the feed-magnets of my improved lamp by the aid of supplementary coils adapted to re-enforce or neutralize, as the case may be, the electro-magnetic action of the shunt-coils of said magnets, together with appropriate connections so arranged that in a lamp of more members than one the electric current shall automatically control and operate the several members thereof to produce the electric light between the members of each set or pair of carbons in succession.

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

In the accompanying drawings, Figure 1 is an elevation, partly in vertical section, of a duplex lamp embodying my invention as applied to an electric lamp of two members. Fig. 2 is an elevation, partly in vertical section, of a triplex lamp, or a lamp of three members, embodying my invention.

In Fig. 1, A and B are two single electric-arc lamps supported in a suitable frame. These lamps are provided each with an automatic feeding device of the kind above mentioned, and indicated in the drawings, and are peculiar in their construction only as hereinafter mentioned. The supporting-springs, embraced in the feed mechanism or devices before mentioned, are of equal stiffness and elasticity. A large wire, P, connected with either pole of the generator—I will say the positive pole—separates at any convenient point into two branches, a and b. The branch a proceeds to the magnet in lamp B, is wound about the cylindrical core thereof, and constitutes the coarse wire coil or helix a'. Then, leaving the said magnet, the same branch, a', passes as a^2 directly to lamp A, where, by means of the binding post w and brush p, it is electrically connected with the carbon rod a^3. The branch wire b proceeds to the magnet of lamp A, is wound about the core thereof, and constitutes the coarse wire coil b'. After being so wound about said core the branch wire b, on leaving said magnet, passes as b^2 directly to lamp B, where it is electrically connected, through the binding-post w' and the contact-brush, p', with the carbon-rod b^3. Likewise a coarse wire, N, from the other pole of the generator separates at any convenient point into two branches, a^6 and b^6, which are respectively connected with the lower carbons, a^5 and b^5.

Over the coil b' in lamp A, in a direction to re-enforce or assist the electro-magnetic action of b', is wound the fine-wire coil d', one end of which is connected, through the connecting-wire d and post w, with the coarse wire a^2, and the other end of which is electrically connected with N through the fine wire d^2; and, in like

manner, over the coil a' in lamp B, in a direction to neutralize or counteract the effect of a', is wound the shunt-coil c'. One end of this coil is connected, through the fine wire c and the post w', with the large wire b^2; and the other end of the same is connected with N through the fine wire c^2.

The coils b' and d' may be arranged in any order, or may be wound side by side, or even on separate cores, without departing from the essence of my invention; but I prefer to wind them in the order named, beginning at the core of a single magnet, as shown. The coils a' and c' may also be arranged in any order, or side by side, or on separate cores, without departure from the spirit of my invention; but I prefer to arrange them about a single cylindrical core in the order named and shown. The shunt-coils d' and c', which are of practically equal efficiency, are severally much stronger than the coils a' and b', severally, which also are of practically equal strength. The shunt-coils are strong enough when in action to overcome the resistance of the supporting or retractile springs in the feed mechanisms before mentioned, while the coils a' and b' are not of sufficient power to accomplish that result. The feed mechanism of A and B are to be actuated by said magnets, wound as above.

Such being the construction of my duplex 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 are held apart from each other by the power of the supporting-springs embraced in the feed mechanisms of the respective members of the lamp, and are not in contact; but as soon as the current from the generator is passed through the lamp, the current from P, Fig. 1, follows the branch wires a and b through the two members of the lamp in the following courses, viz: That portion of said current which follows the branch wire a passes through the helix a', the connecting-wire a^2, and the shunt d, d', and d^2 to N, and the generator. That portion thereof which follows the branch wire b passes through the helix b', the connecting-wire b^2, the shunt-wires and coil c, c', and c^2 to N, and the generator. Such is the twofold 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 through the shunt-coils is to draw down the spring-armature of the feed mechanism in each member of the lamp, whereby the carbons of each set are fed together to actual contact. The circuit is thereby closed through both sets of carbons. In lamp A the circuit is closed through P, a, a', a^2, a^3, a^4, a^5, a^6, and N, and in lamp B through P, b, b', b^2, b^3, b^4, b^5, b^6, and N, and as these courses offer less resistance to the passage of the current than do the courses before delineated through the said shunt-coils, only a slight current now passes through d' and c'. The combined electro-magnetic effect of the coils d' and b' is now equal to the sum of their several electro-magnetic effects, and the combined effect of the electro-magnetic action of a' and c' is equal to the difference of their several effects. In other words, the effect of the passage of the electric current through both lamps while the carbons are in contact is that in lamp A the electro-magnetic action of d' is reenforced by that of b', while in lamp B the electro-magnetic action of c' is neutralized by that of a'. For the time being, therefore, the magnet in lamp B attracts its armature with less force than that with which the magnet of lamp A attracts the armature belonging thereto. The armature in lamp B is no longer attracted or drawn downward with sufficient force to resist and overcome the energy of the spring in the feed mechanism therein. By the action of said spring and the spring-clamp in lamp B the carbon rod b^3 and the upper carbon, b^4, are immediately drawn upward, whereby the carbons b^4 and b^5 are separated from each other, and the whole current from P to N, except that which traverses the shunts, is caused to pass between the carbons a^4 and a^5. The reason why the voltaic arc does not appear between b^4 and b^5 when the latter are first separated in the manner just described lies in the fact that the carbon current of lamp B is then short-circuited through the carbons of lamp A. The breaking of the circuit at b^4 b^5, as described, leaves the armature and feed mechanism of lamp A to be actuated by the current through the shunt-coil d'. Hence, lamp A now operates in the usual manner as a single lamp of the type specified—that is to say, the current being short-circuited through the carbons a^4 and a^5, a diminished current is sent through the shunt-coil d', so that the armature of the feed mechanism of this member, being drawn downward by its magnet with less force than it is drawn upward by its spring, is retracted by the latter, the rod a^3 is raised, the carbons a^4 and a^5 are separated, and the voltaic arc is produced between them, as shown in Fig. 1. In proportion as a^4 and a^5 are consumed, and the distance between their points increases, the strength of current through the shunt coil d' is increased, and the armature is drawn down, and with it its appurtenant spring-clamp, until the rod a^3 is released, and the upper carbon, a^4, falls until the current through the shunt coil d' is diminished by the shortening of the arc, the armature is released, and the spring-clamp again holds the carbon rod a^3. The separation of b^4 and b^5 in the sequence here described results necessarily from the counter-action of the coils a' and c', before explained, and after being separated, as described, the carbons b^4 and b^5 are kept apart by the same means which brought them apart, so long as the counter-action of said coil a' and c' continues—that is to say, until the current through a' is interrupted by the separation and consumption of the carbons a^4 and a^5, hereinafter explained. This fixes the light in lamp A regardless of which set of carbons may have

struck first in coming together at first, as above described, and prevents the light from dodging back and forth between the sets of carbons. This is a prime feature of my invention, for the principal difficulty to be overcome when two or more single lamps or sets of carbons are combined to form a duplex or multiplex lamp is to cause one of such sets, and invariably the same set, to operate first, and to cause another, and invariably the same other set, to operate next in order, and so on in a fixed and predetermined order, and to bring the carbons of each set together while the others are held apart. Otherwise the light might appear in either member, and pass from member to member indiscriminately. The illumination in lamp A continues, the carbons in lamp B are held apart in the manner stated, and the upper carbon, a^4, is fed down gradually, is consumed, just as in my single lamp, patented as above, until the feed in lamp A is arrested by means of the stop on the carbon-rod a^3. Then, as the gradual consumption of the carbons in lamp A continues, while feed no longer takes place, the voltaic arc between a^4 and a^5 lengthens, and an increasing current is passed through the said shunt-coils by the way of the fine wires before mentioned. As the current through the shunt-coils increases, the shunt-coil c' overcomes and neutralizes the effect of the coarse wire coil a', and causes the lamp B to feed until its carbons b^4 and b^5 meet again in electrical connection. Then the whole current which previously passed through the carbons a^4 and a^5 at once passes through the carbons b^4 and b^5, and the light in A goes out; at the same time the armature and feed mechanism of lamp B are left to be actuated by the current through the shunt-coil c', while c' is at a minimum of efficiency by reason of the short circuit through the carbons b^4 and b^5. The armature above is therefore released and the carbon-rod b^3 and carbon b^4 are lifted by the spring and spring-clamp of the feed mechanism of this member. The carbons b^4 and b^5 are thereby separated, and the voltaic arc appears between them. Lamp B now continues to act as a single lamp of the type before specified. It will of course be understood that the electric current through c' and d' is never fully interrupted while this duplex lamp is in operation. From the foregoing explanation it will also be understood that the differential magnet in lamp B operates differentially while a current passes between a^4 and a^5, and practically at no other time, and that the magnet in lamp A operates as a re-enforced magnet when a current passes from b^4 to b^5, and practically then only.

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

In Fig. 2, A, B, and C are the magnets which severally actuate the feed mechanisms of the three members of such lamp, respectively. Each of said magnets is wound with a fine wire or shunt coil and with two separate coarse wire coils. In magnet A the two coarse wire coils b' and c', are wound and connected to act as supplementary coils, adapted to re-enforce the action of the shunt-coil d' in the same. In magnet B the coarse wire coil a' is a neutralizing or differential coil, and c^3 is a supplementary or assisting coil, as related to the shunt-coil e' in the same magnet. In magnet C the two coarse wire coils a^3 and b^3 are wound and connected to act as neutralizing coils, adapted to counteract the effect of the shunt-coil f' in the same. The three coils of each magnet may be arranged in any order or position, or even on separate cores. In each magnet the shunt-coil is stronger than either of the remaining coils of the same magnet, and all the coarse wire coils in the lamp are of practically equal strength. All the coils or helices represented in Fig. 2 are of coarse wire, excepting the shunt-coils d', e', and f'. The three latter are of fine wire, and are connected as shunts about their respective carbons in the usual manner. In my triplex lamp a large wire, P, Fig. 2, connected with one pole of the generator, divides at any convenient point 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^8, b^8, and c^8, which are in any convenient manner electrically connected with the three lower carbons of the triplex lamp, one branch with each lower carbon.

The construction in other particulars and the remaining connections of this lamp will be readily understood from the operation of the lamp, as hereinafter explained, from an inspection of the drawings, Fig. 2, and from the foregoing description of like connections and like features of construction in my duplex lamp.

It will be observed, in view of the construction and connections mentioned, that the carbon current of each member of my triplex lamp is conducted about the magnet of each preceding member of the same lamp as a supplementary coil adapted to re-enforce the shunt coil of each such preceding member, whereby to produce feed, and about the magnet in each succeeding member of the same lamp as a differential coil to neutralize the shunt-coil of each such succeeding member, to prevent feed therein.

In Fig. 2 the connection of the wire a^4 and the carbon-rod a^5 is indicated as immediate, instead of being represented as effected by contact-brush or other appropriate means; and for convenience the connections b^4 b^5, as well as c^4 c^5, are represented in the same manner.

Such being the construction of my triplex lamp, the mode of its operation is as follows: When no current passes through the lamp, the positive and negative carbons of each set are separate, being held apart from each other

by the spring-clamp, or other equivalent device belonging to the feed mechanism; but when a current is passed through the lamp, the connections having been made as indicated, the electric current from P, Fig. 2, passes in three branches, *d*, *e*, and *f*, to the magnets A, B, and C, respectively. There it passes through the shunt-coils *d'* *e'* and *f'*, severally, and thence by the fine wires d^2, e^2, and f^2, passes to N and the generator. The effect of the passage of such current from P to N through the shunt-coils, as described, is to draw down the armature in the feed mechanism in each member of the lamp, whereby the carbons in each member are caused to approach each other until the carbons of each set are in actual contact. The circuit P to N is then closed through each pair of carbons. In the first member it is so closed through P *a* a' a^2 a^3 a^4 a^5 a^6 a^7 a^8 N. In the second member it is so closed through P *b* b' b^2 b^3 b^4 b^5 b^6 b^7 b^8 N; and in the third member through P, *c*, c', c^2, c^3, c^4, c^5, c^6, c^7, c^8, and N. Only a very slight current then passes through the shunt-coils, for the current is short-circuited through the carbons. The effect of the passage of the current from P to N in the triple course last described is that in lamp A the electro-magnetic action of *d'* is re-enforced by that of *b'* and *c'*. In magnet B the action of *c'* is re-enforced by that of c^3, and counteracted by that of *a'*, while in magnet C the effect of *f'* is opposed by that of a^3 and b^3, the combined effect of which action and counteraction is that magnet A is more strongly energized to cause feed, in the manner before described, than either of the other magnets B and C; while the magnet C is actuated least of all, and the magnet B exerts an intermediate degree of force as a feeding-magnet. The magnet C therefore no longer attracts or draws downward its armature with sufficient power to overcome or resist the retractile energy of the spring which is attached thereto. The carbon rod c^5 and carbon c^6 are therefore drawn upward and away from the carbon c^7 by the action of the said spring and of the spring-clamp belonging thereto, whereby the carbons c^6 and c^7 being separated, the current through and between them is interrupted, being short-circuited through the branch-wires *a* and *b* and the corresponding carbons, a^6 a^7 and b^6 b^7. Thus the whole current from P to N, except the insignificant part thereof which traverses the shunt-coils, is caused to pass between the carbons a^6 a^7 and the carbons b^6 b^7. The reason why the voltaic arc does not appear between c^6 and c^7 when they are first so separated lies in the fact that the current is then short-circuited through the remaining carbons, as just explained. The interruption, in the manner stated, of the current which proceeded by the course P *c* c' c^2 c^3 c^4 c^5 c^6, &c., leaves the magnets A and B inoperative, so far as respects their respective coils c' and c^3, so that magnet A is for the time being practically reduced thereby to a magnet of two coils, *b'* and *d'*, and magnet B to a magnet of two coils, *a'* and *c'*. A and B are thus for the time being constructed and connected in practically the same way, are placed in practically the same predicament, 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 of my duplex lamp hereinbefore explained, after the carbons have been fed to contact, in my said duplex lamp. In short, the magnets A and B then become for the time being the magnets of a duplex lamp of the type above described and explained, embracing the two members of my triplex lamp which contain said magnets. And when, in the operation of such practically-duplex lamp containing the magnets A and B, the carbons a^6 and a^7 have been first consumed and separated, then the magnets B and C practically become in turn and for the time being the magnets of duplex lamp of the same type, and operate in the same way as do the said magnets of my duplex lamp to feed the carbons to contact, to separate the same successively, and to produce the electric light next between b^6 and b^7, and finally between c^6 and c^7.

From the above it is obvious that in my improved lamp the carbons constitute or furnish 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 greater number of members, if that should become desirable, by simple extension and addition, without the introduction of any new principle.

There is no need of any switch-magnet in any particular member of my improved lamp; but it is desirable to have a switch-magnet or automatic cut-out in each such lamp considered collectively, which cut-out may be of any ordinary construction and arrangement. In Fig. 2 such a cut-out is indicated at S between N and the generator.

So far as concerns the present case I disclaim all things which are claimed in my application No. 105,092, for a patent for improvement in electric lamps, filed August 30, 1883; but now

I claim as my invention and desire to secure by Leters Patent—

1. 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 electro-magnets, the first magnet in said series being wound with a shunt-coil and with one or more supplementary coils, and the last magnet in said series being wound with a shunt-coil and with one or more differential coils, in which lamp each such set or pair of carbons constitutes a pair of

contacts in a compound automatic switch regulating such lamp and co-ordinating the functions thereof.

2. In an electric-arc lamp having two or more pairs or sets of carbons whose feed mechanisms are actuated by a series consisting of a corresponding number of magnets, the first magnet in said series being wound with a shunt-coil and with one or more coils supplementary thereto, and the last magnet in said series being wound with a shunt-coil and with one or more differential coils, a compound automatic switch whose contact-points severally coincide with the points of said carbons.

3. The feed mechanism of an electric-arc lamp, in combination with an electro-magnet which is furnished with a spring-armature or its equivalent and is wound differentially and supplementarily, with independent coils or helices for operating the same, so that one or more of said coils may be energized without the others, so that two or more of said coils, the same being wound in one and the same direction, may re-enforce or assist each other when traversed by the electric current, and so that two or more of said coils, the same being wound in different directions, may neutralize or counteract each other when energized, whereby the action of the said feed mechanism may be governed and determined by the number, direction, and electro-magnetic energy of such of the said coils as are for the time being brought into operation.

4. An electro-magnet wound differentially and supplementarily with several independent coils or helices for operating the same, and furnished with a spring-armature or its equivalent, in combination with a carbon rod or holder, and intermediate feed mechanism of an electric-arc lamp, whereby the carbon which is carried by such rod or holder may be raised, lowered, or held up according to the number, direction, and electro-magnetic energy of such of the said coils as are for the time being brought into operation.

5. In an electric lamp, a pair or set of carbons, a carbon rod or holder, and a magnet wound with independent supplementary coils, in combination with intermediate feed mechanism, whereby said carbons may be made to approach, recede, or stay apart, according to the number and electro-magnetic energy of the coils of such magnet which are for the time being traversed by the electric current.

6. In an electric lamp containing two or more pairs or sets of carbons, a series consisting of a corresponding number of electro-magnets, the first magnet in said series being wound with a shunt-coil and one or more coils supplementary thereto, and the last magnet in said series being wound with a shunt-coil and with one or more coils differential thereto, in combination with spring armatures which are actuated similarly or dissimilarly thereby, according to the course pursued for the time being by an electric current in passing through said magnets.

7. In an electric-arc lamp containing two or more pairs or sets of carbons, a series consisting of a corresponding number of supplementarily and differentially wound electro-magnets, in combination with armatures of said magnets actuated thereby to produce similar or dissimilar motion or rest in said armatures, according to the course pursued for the time being by an electric current energizing said magnets.

8. In an electric lamp containing two or more pairs or sets of carbons, a corresponding number of inter-connected electro-magnets wound with independent coils, in combination with feed mechanisms actuated thereby, whereby the action of such feed mechanisms is governed and determined by the course pursued by an electric current energizing said magnets.

9. In an electric-arc lamp containing two or more pairs or sets of carbons, a series consisting of a corresponding number of electro-magnets, the first magnet in said series being wound with a shunt-coil and with one or more coils supplementary thereto, and the last magnet in said series being wound with a shunt-coil, and with one or more coils differential thereto, in combination with a corresponding number of carbon-supporting rods and intermediate feed mechanisms actuated by said magnets, whereby said carbon-supporting rods may be independently raised, lowered, or held in position, according to the number, direction, and strength of the currents energizing said magnets.

10. In an electric lamp, two or more pairs or sets of carbons, and a corresponding number of differential and supplementary magnets, in combination with intermediate mechanisms actuated by said magnets to impart to said sets of carbons independent separating and feeding movements, whereby the electric light may be established between the members of one of said pairs or sets at a time, while the members of the remaining pair or pairs are held apart.

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

RICHARD H. MATHER.

Witnesses:
GEORGE C. MCKEE,
HENRY E. PRATT.