(No Model.)

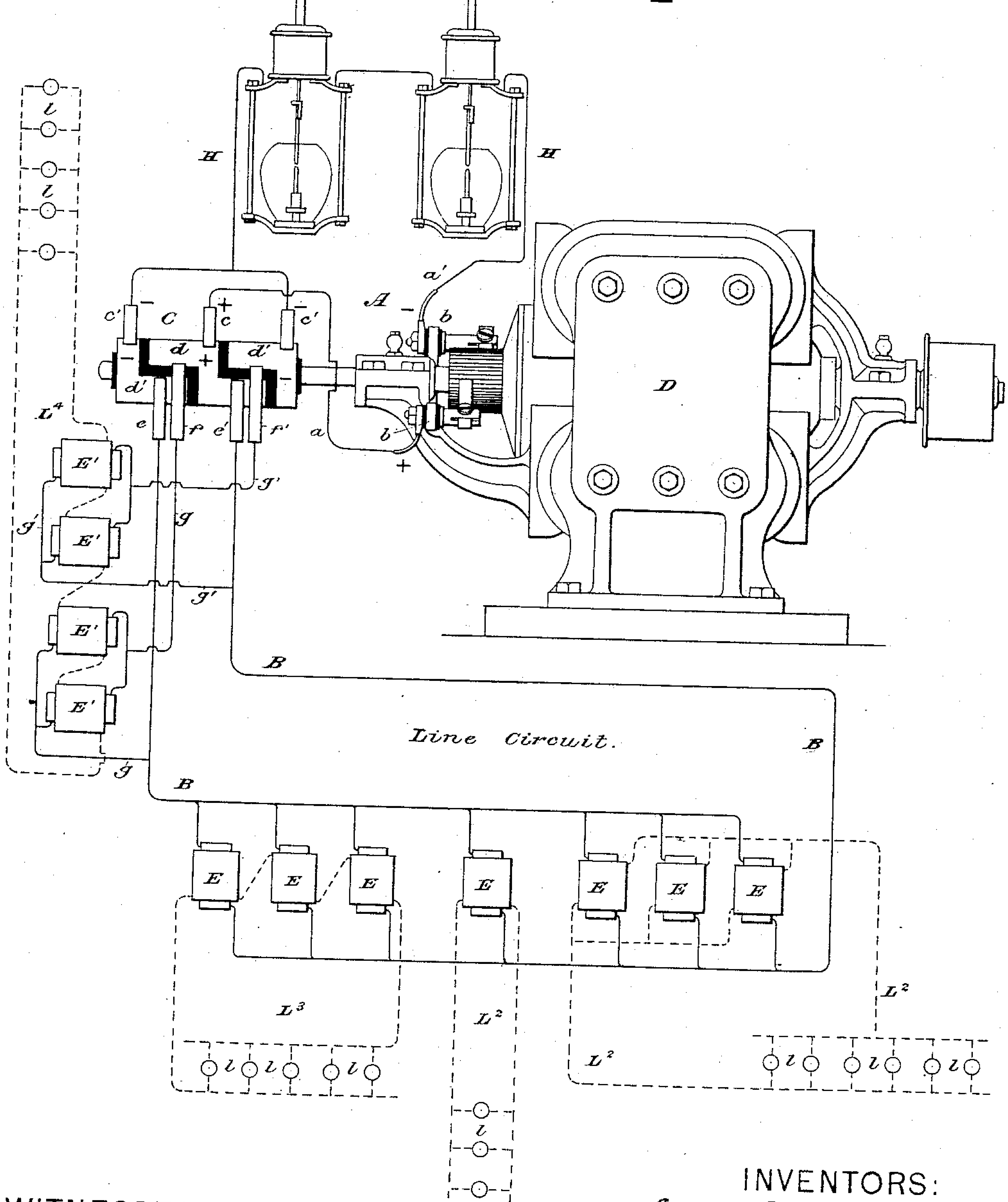
2 Sheets—Sheet 1.

G. & A. PFANNKUCHE.

DISTRIBUTION OF ELECTRIC ENERGY.

No. 343,603. Patented June 15, 1886.

Fig. 1.



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(No Model.)

2 Sheets—Sheet 2.

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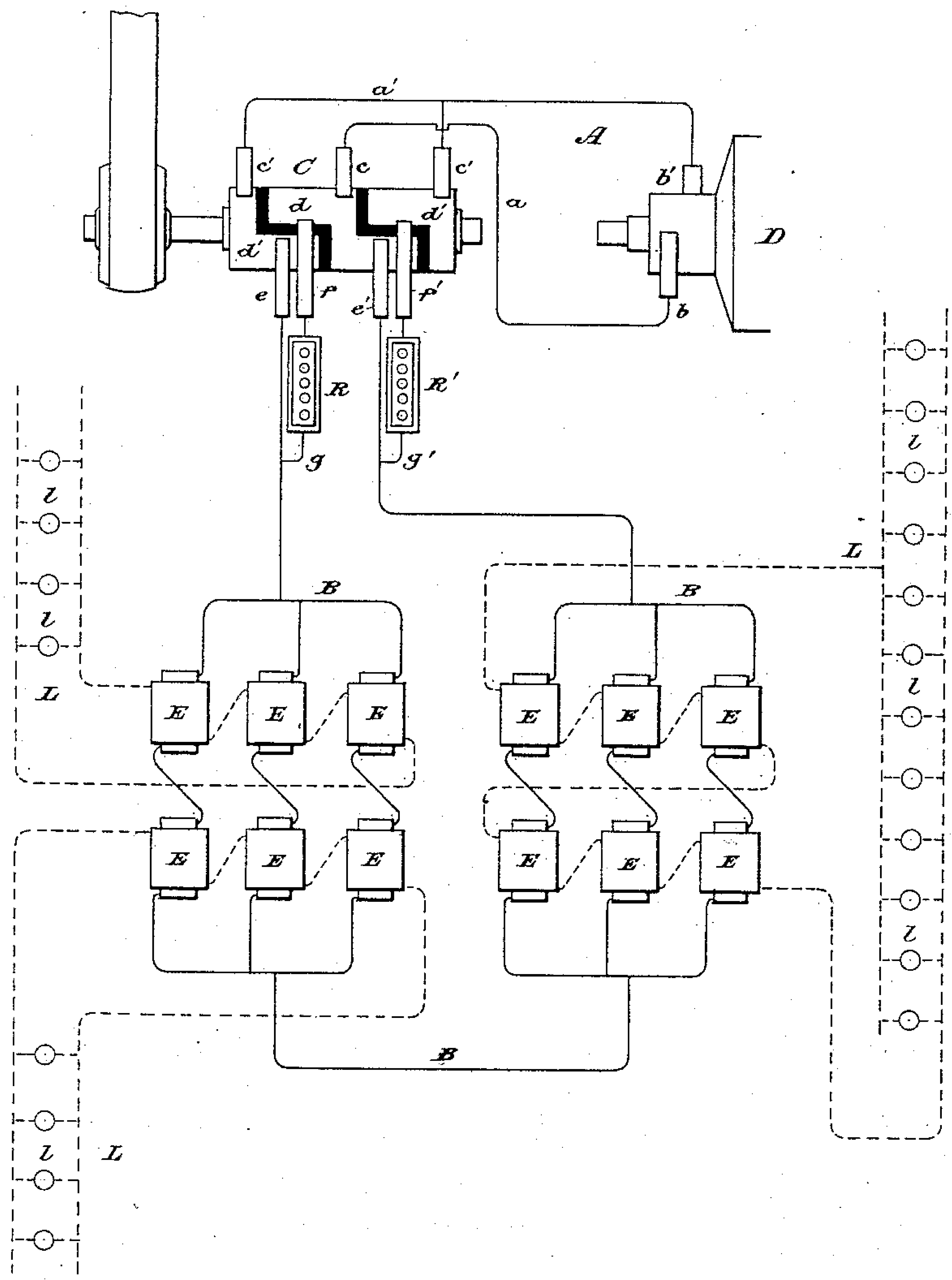
Fig. 2.



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UNITED STATES PATENT OFFICE.

GUSTAV PFANNKUCHE AND ALFRED PFANNKUCHE, OF NEW YORK, N. Y.

DISTRIBUTION OF ELECTRIC ENERGY.

SPECIFICATION forming part of Letters Patent No. 343,603, dated June 15, 1886.

Application filed September 28, 1885. Serial No. 178,351. (No model.)

To all whom it may concern:

Be it known that we, GUSTAV PFANNKUCHE and ALFRED PFANNKUCHE, both subjects of the Emperor of Austria, and residents of the city, county, and State of New York, have invented certain new and useful Improvements in the Distribution of Electric Energy, of which the following is a specification.

In circuits for transmitting low-tension currents, such as are employed in incandescent electric lighting on the multiple-arc system, the main-line conductors are required to be of such large area of cross-section that their expense for long circuits becomes an important barrier to the introduction of this system of lighting. Not only is the first cost of the conductors excessive, but the loss of potential along the lines is an important detriment to the economy of the system. To avoid these objections, and enable the current for maintaining such lights to be transmitted to great distances over as small a wire as are the currents for feeding arc lamps, and with as little loss of energy in transit, it has been proposed by several inventors to employ upon the line alternating currents of high electro-motive force, and to transform these currents at the station of the subscriber into induced currents of low electro-motive force and considerable quantity in a local circuit, in which local circuit the incandescent lamps are intercalated in multiple arc. This system, while perfect in theory, has never proved profitable in practice for two reasons: First, an alternating-current generator has had to be used, which is not only more complicated and expensive than the dynamos producing continuous currents, but has also a much lower efficiency, so that the useful electric energy delivered to the line is disproportionately expensive; second, the induction-coils or converters through which the line-circuit acts upon the local circuits of the subscribers, as heretofore constructed, have been extremely wasteful of energy, converting but a small portion of the energy consumed from the line circuit into useful electrical effect in the local circuits. The latter defect is remedied by an improved converter embodied in our application for patent on electric-current converters, designed to be filed simultaneously herewith. [Application No. 178,350, filed September 28, 1885.] The former defect our present invention is designed to remedy, as well as to add to the system advantages which it has not heretofore possessed.

In place of the alternating-current generator of low efficiency heretofore used, we employ a continuous-current generator, and transform its continuous currents into alternating currents by means of an alternating commutator. The circuit from the generator to this commutator thus carries continuous currents, and may be used for operating electric-arc lamps, electromotors, or other devices requiring continuous currents. The circuit beyond the alternating commutator carries alternating currents and traverses the primary coils of the inductoriums or converters. The several local circuits of the subscribers, or at the places where a quantity current of low tension is desired, traverse the secondary or coarse wires of the converters, and include the incandescent lamps or other devices to be fed by alternating currents of low tension.

Figure 1 of the accompanying drawings shows a dynamo-alternating commutator, and the circuits and other devices in connection therewith in accordance with our invention. Fig. 2 shows a modification thereof.

Let D designate the dynamo, which may be of any known type suitable for producing continuous currents; A, the circuit extending from the brushes thereof to the commutator; C, the alternating commutator for transforming continuous into alternating currents; B, the line-circuit extending from one terminal at the alternating commutator to the several inductive points or subscriber's stations and back to the other terminal at the commutator; E E, the several inductive-current converters or inductoriums, one or more of which is located at each subscriber's station, and L L the local circuits on the subscriber's premises. The latter circuits are shown by dotted lines, and have incandescent lamps *l l* installed in multiple arc, or electromotors or other devices.

From the brushes *b b'* of the dynamo lead the wires *a a'* of the circuit A. One of these wires, *a*, terminates at a brush, *c*, and the other, *a'*, is branched and leads to two brushes, *c' c'*.

The alternating commutator C, as shown, consists of three segments, *d* and *d' d'*, mounted on the prolonged armature-spindle of the dynamo, and insulated therefrom and from each other. The middle segment, *d*, is made cylindrical at its center, and has semi-cylindrical arms projecting therefrom in axially-opposite directions and on diametrically-opposite sides, and the outer segments, *d' d'*, are made cylindrical at their ends, and each has a semi-cylindrical arm projecting axially and overlapping one of the like arms of the middle segment. The wire *a* brings positive currents to the brush *c* and segment *d*, while the wire *a'* brings negative currents to the brushes *c' c'* and segments *d' d'*. Two take-off brushes, *e e'*, which we will call the "primary" brushes, are joined to the opposite terminals of circuit B, and rest against the commutator C in such position that each shall contact alternately with the positive segment *d* and one of the negative segments *d'*, and so that while one is in contact with the positive segment the other shall be in contact with the negative segment; hence when the commutator revolves the line-circuit B receives alternate positive and negative impulses, one to each revolution. In addition to the primary brushes *e e'* there are also two secondary brushes, *f f'*, which have a slight lead relatively to the primary brushes, and which are connected through branch wires *g g'* to the respective wires of the line-circuit B, as most clearly shown in Fig. 2, where rheostats R R' are intercalated in these branch wires. Each of these rheostats has a resistance equal to or somewhat in excess of the total resistance on the line-circuit B from one terminal at the commutator C to the other. The reason of this construction may now be understood. If only the brushes *e e'* were employed to take off the current from the alternating commutator, the circuit would be broken whenever either of these brushes passed over the insulation between the commutator-sections—that is to say, twice to each revolution. This would occasion violent sparking at the commutator and heating of the armature-coils, which would be ruinous to the dynamo and the commutator. This is prevented by using both primary and secondary brushes, and setting one as much in advance of the other as the width of the insulation, so that at the instant of crossing the insulation the leading brush makes contact with the positive segment before the other breaks contact with the negative segment, so that the circuit to the dynamo is never broken; but this arrangement alone would cause a short-circuiting of the line at each crossing of an insulation, by the positive current flowing, for instance, into brush *e*, and thence back through brush *f* to the negative segment without traversing the line B. Thus the entire resistance of the line would be cut out for an instant twice at each revolution, thus heating and injuring the dynamo. The resistance R prevents this result, not by preventing the short-circuiting from brush *e* to *f* and *e'* to *f'*, but by making this short circuit of equal resistance to the line, so that the dynamo feels no difference whether the current traverses the line or the short circuit. In this manner the circuit to the dynamo is in effect neither broken nor short-circuited, and no sparking nor heating is caused. It is apparent that during the instant while the brushes *e f* are on opposite sides of the insulation there will be no current supplied to the line-circuit B, but upon both brushes reaching the same segment of the commutator C the current to the line will be established in a direction reversed relatively to the preceding current. The rapidity of the alternation of the currents in the line-circuit will depend upon the speed with which the alternating commutator is revolved. If it be fixed on the armature-shaft, as shown in Fig. 1, it will revolve at the same speed as the armature, usually from nine hundred to twelve hundred revolutions per minute. This is undesirably rapid, a speed of only about two hundred revolutions being much preferable. We prefer, therefore, to fix the alternating commutator on a separate shaft, as shown in Fig. 2, and drive it independently at whatever speed may from time to time be desired.

The several converters E E are essentially inverted induction-coils—that is to say, their coils of fine wire constitute the primaries, and are joined in the line-circuit, and their coils of coarse wire constitute the secondaries, and are joined in the local circuits. We much prefer the construction disclosed in our said application for patent; but any other construction giving sufficient economy may be used. The primary coils may be joined in the line-circuit in multiple arc, multiple series, or otherwise, as the judgment of the electrician shall dictate; but it is obvious that but one system should be pursued with all the converters—that is, if the multiple arc be chosen, as shown in Fig. 1, they should all be placed in multiple arc, and their primary coils should be of uniform resistance. Fig. 2 shows the coils connected in multiple series.

The secondary coils of the converters may be joined in the local circuits in any desired way, according to the work which the several local circuits are expected to perform. In Fig. 1 we have shown three different methods—the circuit L', including but one converter, the circuit L^2, including three converters installed in multiple arc, and the circuit L^3, including three converters installed in series. In either case the incandescent lamps *l l* may be joined in multiple arc, as shown, or in any other arrangement that experience may dictate.

The regulation of the circuit from time to time in accordance with the varying work to be done is accomplished in any manner heretofore used for the regulation of circuits for arc or incandescant lighting by continuous currents—namely, by a regulator attached to or forming part of the dynamo. We prefer that the dynamo shall be wound with a compensating winding, as is well known, whereby it becomes self-regulating, being constructed to maintain uniform potential at the terminals; or a distinct regulating device may be used in case it is desired to maintain a uniform current. The continuous current in the circuit A being thus maintained of a uniform potential or uniform volume, it follows, of course, that the alternating current in the circuit B shall be likewise maintained uniform.

In the use of rheostats R R′ more or less energy expended in overcoming the resistance is wasted by being converted into heat. To economize this waste, we substitute for the rheostats one, two, or more converters, E′ E′, identical with those in the main line, except that the resistance of their primary coils may require to be somewhat different. In Fig. 1 we have shown two converters, E′, intercalated in multiple arc in each of the branch wires *g g′*. The resistance of the primary coils of these converters should be such that each branch circuit *g g′* will have a resistance equal to or slightly exceeding that of the entire main line. The secondary coils of the converters E′ E′ are connected in a local circuit, L^4, which will have the capacity of maintaining a few incandescent lamps, sufficient, probably, to light the generating station or some adjacent apartment.

As before stated, the circuit A may be used to feed arc lamps or other electric devices requiring continuous currents. In Fig. 1 we have shown two arc lamps, H H, included in this circuit by way of illustration. Thus our invention solves the problem of supplying both arc and incandescent lights from one dynamo, which proves frequently desirable in isolated plants.

It will be understood that the commutator of three sections is shown only for the sake of clearness, since in practice a commutator of two sections will answer the purpose equally well, the opposite take-off brushes being arranged on diametrically-opposite sides.

Any other suitable construction of commutator may be substituted for the one shown.

We are aware of a system of current distribution the purpose of which is identical with ours, which consists in the employment of high-tension continuous currents upon the line-circuit, with a current-alternator at each local station for reversing the currents passing through the primary of an induction-coil with which it is connected, thereby effecting the generation of induced currents in the local circuit without disturbing the continuity of the currents on the line. The current alternator is in one instance a vibratory pole-changer actuated by a polarized electro-magnet, and in another instance it is a rotary commutator driven by an electro-motor or other source of power.

Our invention is limited to the employment of an alternating commutator at the generating-station or elsewhere, where it can cause the alternation of the current on the line-circuit, and where its speed can be controlled so as to effect such rate of current alteration as will give the best inductive results.

We claim as our invention—

1. The combination of a dynamo generating continuous currents, a circuit leading from the terminal brushes thereof to a current-alternating commutator, the said commutator, a line-circuit for conveying alternating currents, with its terminals leading to the opposite take-off brushes of said commutator, two or more inductive current-converters with their primary coils joined in the line-circuit, and two or more local circuits each including the secondary coil of one or more of said converters, substantially as and to the effect set forth.

2. The combination of a dynamo generating continuous currents, a circuit leading thence to a current-alternating commutator, one or more electric-arc lamps or other electrical devices connected to said circuit and receiving continuous currents, the said commutator, and means for driving it, a line-circuit carrying alternating currents and terminating in the opposite take off brushes of said commutator, inductive current-converters with their primary coils joined in said line-circuit, one or more local circuits including the secondary-coils of said converters, and incandescent lamps or other electric appliances included in said local circuits, substantially as set forth, whereby both arc lamps (or equivalent devices) and incandescent lamps are supplied from the same dynamo.

3. The combination of a continuous-current dynamo, a current-reversing commutator consisting of positive and negative segments, circuit-connection between said segments and the respective terminals of said dynamo, the take-off brushes of said commutator, a line-circuit with its terminals connected to said brushes, secondary take-off brushes arranged with a lead relatively to said primary brushes, whereby the leading brush shall make contact with the segment on one side of the insulation before the following brush breaks contact with the segment on the other side of the insulation, a branch circuit leading from each of said supplementary brushes to the line-circuit, and a resistance in each of said branch circuits balancing the resistance of the line-circuit, substantially as set forth.

4. The combination of a continuous-current dynamo, a current-reversing commutator consisting of positive and negative segments, circuit-connection between said segments and the respective terminals of said dynamo, the take-off brushes of said commutator, a line-circuit with its terminals connected to said brushes, secondary take-off brushes arranged with a lead relatively to said primary brushes, whereby the leading brush shall make contact with the segment on one side of the insulation be-

fore the following brush breaks contact with the segment on the other side of the insulation, a branch circuit leading from each of said supplementary brushes to the line-circuit, one or more inductive-current converters with their primary coils installed in said branch circuits respectively, and a local circuit including the secondary coils of said converters, substantially as set forth.

In witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

GUSTAV PFANNKUCHE.
ALFR. PFANNKUCHE.

Witnesses:
ARTHUR C. FRASER,
E. B. BOLTON.